Health Sector Labour Market Dynamics and Multi-Employer Collective Agreements

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Health Sector Labour Market Dynamics and Multi-Employer Collective Agreements
-
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1 Introduction

Economic enquiry upon the health-sector often has a demand focus which has missed some of the more interesting "supply-side" features of the industry. The "cost of" unhealthy consumer behaviour; the inequalities of access to health care; the prevalence and incidence of disease, are rich "demand-side" research areas. Supply-side economic enquiry: the health-sector's structure, its production processes, its cost-drivers, its capital and labour markets, and its adaptability to change, have received less researcher attention. Part of the reason relates to the paucity of good supply-side data: detailed reliable information on health-sector costs and inputs are not readily available. While high demand-side research interest remains, the lack of supply-side economic data diminishes the attractiveness of supply-side health-sector research for researchers.

The lack of health-sector supply-side economic research has resulted in some of the discipline's major insights being unapplied. The optimality of resource allocations, the quality of information available for decision-making, the returns earnt by economic factors-of-production, and the flexibility and adaptability of free-markets are well-known characteristics of competitive markets. Uncompetitive markets misallocate resources across industries; misallocate resources within an industry; entrench existing methods and techniques of manufacture; confer unwarranted privilege, and prevent agents receiving an appropriate share of surpluses from production. While competitive market restrictions may sometimes be justified,[1] the societal welfare losses from overly restrictive departures from competition behove the robust periodic review of restrictive institutional arrangements or practices.

The health-sector's output and labour markets are highly non-competitive. The New Zealand Government dominates health-service purchasing and its service provision. The labour market is highly non-competitive, partly by design through the Health Practitioner Competency Assurance Act 2003 (HPCA), but also through how the HPCA Act has been implemented by Responsible Authorities (RA) empowered by the Act. The majority of DHB workers are employed under "Multi-employer Collective Agreements" (MECAs) that govern all aspects of their employment relationship. MECAs are nationally negotiated agreements between individual District Health Boards (DHBs), who negotiate collectively, and incorporated societies that act as unions, dominated by four health-specific organisations.

[1] For example, where supplier failure could cause disproportional harm to consumers which cannot be insured against or foreseen in advance, provider regulation may be required.

Labour economists generally view unions as "rent-seeking institutions that use monopoly power to transfer economic surplus from other economic agents to their members".[2] Economic theory postulates unions decrease societal welfare, distort economic efficiency, and expropriate economic surplus for their member's pecuniary gain. Through their "monopoly face", unions increase wages, induce firms to employ fewer workers and more capital per worker, and hire higher quality labour than is socially efficient.

How New Zealand's health-sector labour markets interact with the DHB Provider Arms is my thesis' focus. Using health-service delivery data, workforce data, and DHB monthly financial information, I estimate the DHB Provider Arm economic production process and the interaction between DHBs and the health-sector labour and capital input markets.

Production and input market interactions are modelled through simultaneously estimating a DHB production function together with the first order conditions for cost-minimisation in an econometric system-of-equations. Estimating a system-of-equations allows labour and capital market prices to interact with DHB marginal input productivities according to the first order conditions of cost-minimisation. Nationally-determined MECA labour prices influence health-service output through their equality to DHB production-based input marginal productivities. The system-of-equations nature of the modelling process closely connects health-service output to changes in input marginal productivity and input market prices.

Employer labour demand must be price-inelastic for unions to persist. A low input price elasticity allows unions to maintain above-competition wage rates over an extended time period. Simultaneously estimating production and the labour and capital input markets allows the labour price-elasticities for different workforce groups to be directly estimated.

The dataset developed within this thesis for the DHB Provider Arms is part of this thesis' novelty. Neither the production functions, nor the econometric techniques are new. The developed DHB Provider Arm output measure do, however, describe health-service volume changes for 84% of DHB Provider Arm health expenditure. Well understood production functions and econometric techniques, applied to the rich panel data set of monthly Provider Arm output and inputs measures, have produced some surprisingly good results for what has been, up until now, an under-explored economic research area of New Zealand's economy.

The overview of my research is as follows:

[2] Kaufman2004 on page 353

- Section 2 briefly describes my findings. The most preferred econometric result and its interpretation is presented and discussed.

- Section 3 presents economic labour market theory and the economic role of unions. How unions make decisions has consequences for New Zealand's health-sector, and the median voter model of democratic decision-making is described.

- Sections 4 and 5 describes the measurement framework and the data used in this thesis. The data was derived from primary information sources obtained from the Ministry of Health (MoH) under the Official Information Act and supplied by District Health Board Shared Services (DHBSS), a national organisation owned by DHBs.

- Section 6 briefly describes the economic production framework used to explain the interaction between DHBs as economic producers, and the labour markets which they use for purchasing inputs into economic production. Three separate descriptions of production are outlined, together with two separate systems-of-equations used to capture market interactions.

- Section 7 estimates the models described in Section 6 as both single equations of production, and as systems-of-equations. Progressing from simplistic two input Cobb-Douglas production models up to more advanced Constant Elasticity of Substitution, and a Box-Cox specified production function, this section's focus is on exploring the underlying properties of the data, progressively increasing the modelling sophistication. Differences in health service provider elasticities-of-scale become apparent as the models develop and identify separate, secondary and tertiary provider groups. Scale differences and differences in input-intensity also become apparent when labour is differentiated into separate labour workforce group types.

- Section 8 presents the final Cobb-Douglas specified system-of-equations regression model. The preferred model included five labour input measures and one capital measure. The data set developed in sections 5 is a panel dataset which has timeseries and cross-sectional characteristics. Auto-correlation function analysis over the system-of-equation residuals suggests only a limited number of DHB Provider Arms display serially-correlated errors, or hetroskedastic error across the estimated labour markets. The capital market, however, shows significant serial-correlation of its residuals. The capital market estimated results are considered less reliable than the labour market measures.

Section 8 concludes through exploring the comparative statics of the preferred model through estimating the impact of labour and capital input changes. The inter-related nature of the system-of-equations creates initial and induced effects through both the production and the labour markets which, collectively, impact on DHB Provider Arm total workforce costs. Comparative static analysis also separates out secondary and tertiary provider effects.

2 Thesis Findings

rotating

Table (1) reflects the results of a system-of-equations defining DHB Provider Arm production; the health sector labour markets for five health-sector workforces, and the health-sector capital market, estimated using Seemingly Unrelated Regression techniques applied to panel data. The estimated coefficients are shown with their 95% confidence intervals.

The actual and expected modelling results from Table (1) are graphed in section (8.4).

Across the labour markets, the coefficients of the own labour variables are either negatively signed, or statistically insignificant, as would be expected from diminishing marginal returns for each input. Medical and the nursing labour demands are price-inelastic, medical (-0.396) more than nursing (-0.486). Support labour demand is also price inelastic (-0.593), but less inelastic than nursing and medical labour. Allied Health's labour demand elasticity is statistically insignificant, and Management and administration labour (ManAdmin) labour demand is *price-elastic* (-1.105).

The high medical and nursing labour price inelasticity creates the potential for unions to exploit their "monopoly face": lifting both labour prices, and reducing employed workforce volumes, compared to a competitive labour market outcome. The structure of the system-of-equation modelling introduces a rich depth of complexity to modelling comparative static changes since disturbances to either the production or the labour markets "perturb" through the production/labour market system. The inter-related nature of the production function induces secondary labour market price effects within other workforces.

Table 1: Cobb-Douglas System-of-Equations: Final Health Sector Production / Labour Markets Model

	Production	Medical LM	Nursing LM	AH LM	Support LM	ManAdmin LM
(Intercept)	**3.722***	**5.846***	**5.403***	**5.783***	**2.698***	**5.619***
	[3.366; 4.079]	[5.498; 6.194]	[5.150; 5.657]	[5.408; 6.157]	[1.579; 3.816]	[5.229; 6.009]
Tertiary	**3.323***	**0.128***	**0.076***	0.056	−0.069	**0.102***
	[2.127; 4.520]	[0.075; 0.181]	[0.037; 0.114]	[−0.001; 0.113]	[−0.239; 0.102]	[0.043; 0.162]
log(Capital_Quantity_Estimate)	**0.485***	**0.253***	**0.126***	**0.214***	−0.141	**0.163***
	[0.424; 0.546]	[0.209; 0.297]	[0.094; 0.158]	[0.167; 0.262]	[−0.282; 0.000]	[0.114; 0.213]
log(Medical_Labour)	**0.607***	**−0.396***	0.049	−0.007	**0.398***	**0.395***
	[0.538; 0.675]	[−0.473; −0.319]	[−0.006; 0.105]	[−0.089; 0.076]	[0.152; 0.644]	[0.309; 0.480]
log(Nursing_Labour)	**0.272***	**−0.146***	**−0.486***	**−0.755***	**0.923***	**−0.234***
	[0.165; 0.380]	[−0.267; −0.024]	[−0.574; −0.397]	[−0.885; −0.624]	[0.533; 1.312]	[−0.369; −0.098]
log(Allied_Health_Labour)	**0.120***	**0.355***	**0.280***	0.072	**−0.652***	**0.391***
	[0.014; 0.227]	[0.264; 0.447]	[0.213; 0.347]	[−0.026; 0.170]	[−0.945; −0.359]	[0.289; 0.493]
log(Support_Labour)	**0.046***	**0.139***	**0.081***	**0.218***	**−0.593***	**0.147***
	[0.013; 0.080]	[0.103; 0.175]	[0.055; 0.107]	[0.180; 0.256]	[−0.707; −0.478]	[0.107; 0.187]
log(ManAdmin_Labour)	**−0.704***	**−0.397***	**−0.184***	0.042	0.058	**−1.105***
	[−0.805; −0.604]	[−0.490; −0.303]	[−0.252; −0.116]	[−0.058; 0.143]	[−0.242; 0.359]	[−1.210; −1.001]
Tertiary:log(Capital_Quantity_Estimate)	**−0.279***					
	[−0.388; −0.170]					
Tertiary:log(Medical_Labour)	**−0.233***					
	[−0.411; −0.056]					
Tertiary:log(Nursing_Labour)	**−0.498***					
	[−0.810; −0.186]					
Tertiary:log(Allied_Health_Labour)	0.137					
	[−0.024; 0.298]					
Tertiary:log(Support_Labour)	0.032					
	[−0.123; 0.186]					
Tertiary:log(ManAdmin_Labour)	**0.509***					
	[0.318; 0.699]					
R^2	0.983	0.628	0.330	0.587	0.238	0.532
Adj. R^2	0.982	0.623	0.321	0.581	0.227	0.525

Note: Coefficients with $p < 0.05$ in **bold**. Figures in brackets are confidence intervals with $\alpha = 0.05$

The structure of Table (1) implies changes in workforce size and composition have separate effects on secondary and tertiary provider output depending on the relative sizes of each workforce and their production function coefficient. However, the labour market impacts reflect the size of the combined workforces and changes in secondary/tertiary workforce "equilibrate" within the single labour market which responds to total workforce size.

2.1 Modelling Results

Medical labour makes the largest contribution to health-service volume production for both secondary and tertiary providers; however, the output volume impact of medical labour change differs between providers. Increasing medical labour in both secondary and tertiary providers by 10.0% increases health service output by 6.0% and 3.6% for each provider respectively, reflecting the higher medical labour productivities within secondary providers. Total Provider Arm health-service output increases by 4.1% and the total labour cost over all workforces increases 2.5%.

Table (1) indicates tertiary providers show signs of their nursing workforce being "too large", while secondary provider results show there is scope for more nursing employment within their workforces. If the nursing workforce was rebalanced with no change in the total workforce size through tertiary providers decreasing their nursing workforce by 10%, and secondary providers increasing their nursing workforce by 39%, then **IF** such a change could occur nationally, total health service output would increase by 3.9% with no additional increase in DHB Provider Arm workforce costs. Secondary provider output would increase by 9.4%, and tertiary output would increase by 2.4% for no net increase in labour costs across all DHB Provider Arms.

Changing the allied health workforce employed within DHB Provider Arms has a significant effect on the labour prices of virtually all other health workforces. A 10% increase in both the secondary and tertiary provider allied health workforces generates a 2.2% increase in total health services produced within DHBs while across all DHBs, total labour costs increase 4.1%.

ManAdmin are negatively signed within both secondary and tertiary production functions, suggesting ManAdmin labour *decreases* the volume of health-services produced by DHBs. However, ManAdmin are also negatively signed in the labour market functions suggesting ManAdmin play a role in affecting labour market prices for different health-sector workforces.

While the ManAdmin workforces do not directly produce health care, Table (1) suggests they actively decrease the cost of employing other workforces, potentially through improving workforce co-ordination, and generating workforce efficiencies.

2.2 Labour Demand Price Elasticities and the Changing Composition of the DHB Provider Arm Workforce

The *relative* workforce labour demand price elasticities have been a fundamental determinant of DHB Provider Arm workforce composition. With medical labour having the lowest price elasticity of all workforces, workforce labour cost inflation has altered the composition of the DHB Provider Arm workforces. The relative workforce composition of DHBs has become more *relatively*[3] medical-dominant over time (see Figures (1) - (4)).

Labour costs, negotiated with unions through the national MECAs, have resulted in DHBs responding to price increases according to their production-based labour marginal productivities and labour demand elasticities. As labour costs have inflated, the relative difference in each workforce's labour demand price elasticity have altered the composition of virtually all DHB's workforces. Each DHB has become more *relatively* medical-intensive, reflecting medical labour's lower price elasticity compared to other workforces.

Economic theory suggests unions induce allocative inefficiency: they alter relative prices and lead to input distortions which would otherwise not occur within a competitive market. Figures (1) - (4) are evidence of the distortionary effect induced through allocative inefficiency. For the health-sector, a higher employment proportion of medical labour has been induced by the allocative inefficiencies stemming from the cumulative effects of centrally-negotiated MECA agreements on labour prices.

Paradoxically, for the health system, from Table (1), increasing the medical workforce would make the largest contribution for increasing health service output for both secondary and tertiary providers. The low medical labour demand price elasticity in Table (1), reflected in high medical labour costs, has resulted in fewer medical workforce employed then would be allocatively efficient. High medical costs have created medical workforce scarcity such that medical labour has now become the input which has the greatest impact on the production of health services, hence their estimated production contribution from Table (1).

[3]Not *absolutely* dominated

Recent media reports suggest graduate nurses and medically-trained migrants face difficulty getting employed within DHBs.[4] Limited job opportunities for graduates and overseas entrants seeking employment within New Zealand's labour market are the predicted outcomes from the union effects described in section 3.

Overseas-trained workforce, attracted by the high labour earnings available within the unionised New Zealand health-sector labour markets, find themselves shut out of the same non-competitive labour market that confers unions their monopoly power, despite the economic benefit increased medical labour would generate in increased health services. Likewise, nursing graduates who might prefer employment at less than union wages closer to a competitive wage rate find no voice within a union focused on its employed members interests.

The uncertainty is what happens to trained workforces who cannot secure DHB employment and choose to remain within New Zealand's health-sector. Section 3 suggests they secure employment within non-unionised roles at below competitive labour rates, potentially waiting until they become attractive for a unionised role. The Disability Support Service (DSS) and Aged Care industry would seem likely candidates for readily-available private sector employment within the health industry. Figures (45), derived from Figure (44) suggest the DSS workforce are both the lowest paid, and the workforce who has received the least wage inflation of the health-sector industries. Whether the witnessed income changes reflect a large number of highly trained workforce, who have failed to secure DHB employment employed in the DSS workforce, pushing down labour prices, or the competitive labour rates for a less skilled workforce is a largely unknown question.

[4] http://tvnz.co.nz/national-news/nursing-graduates-struggling-find-work-5805893 and http://www.radionz.co.nz/news/national/240482/foreign-doctors-demand-action-on-jobs

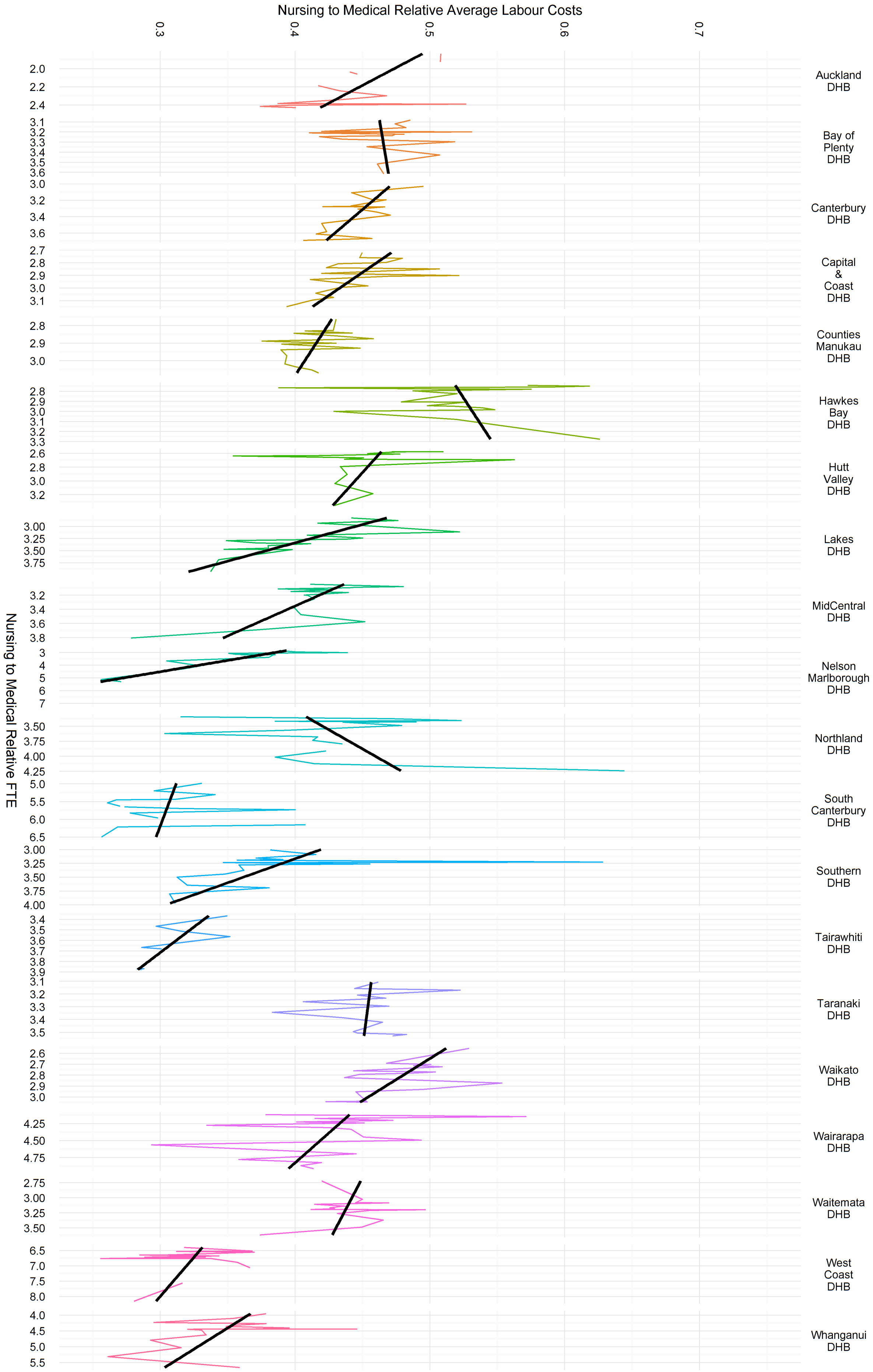
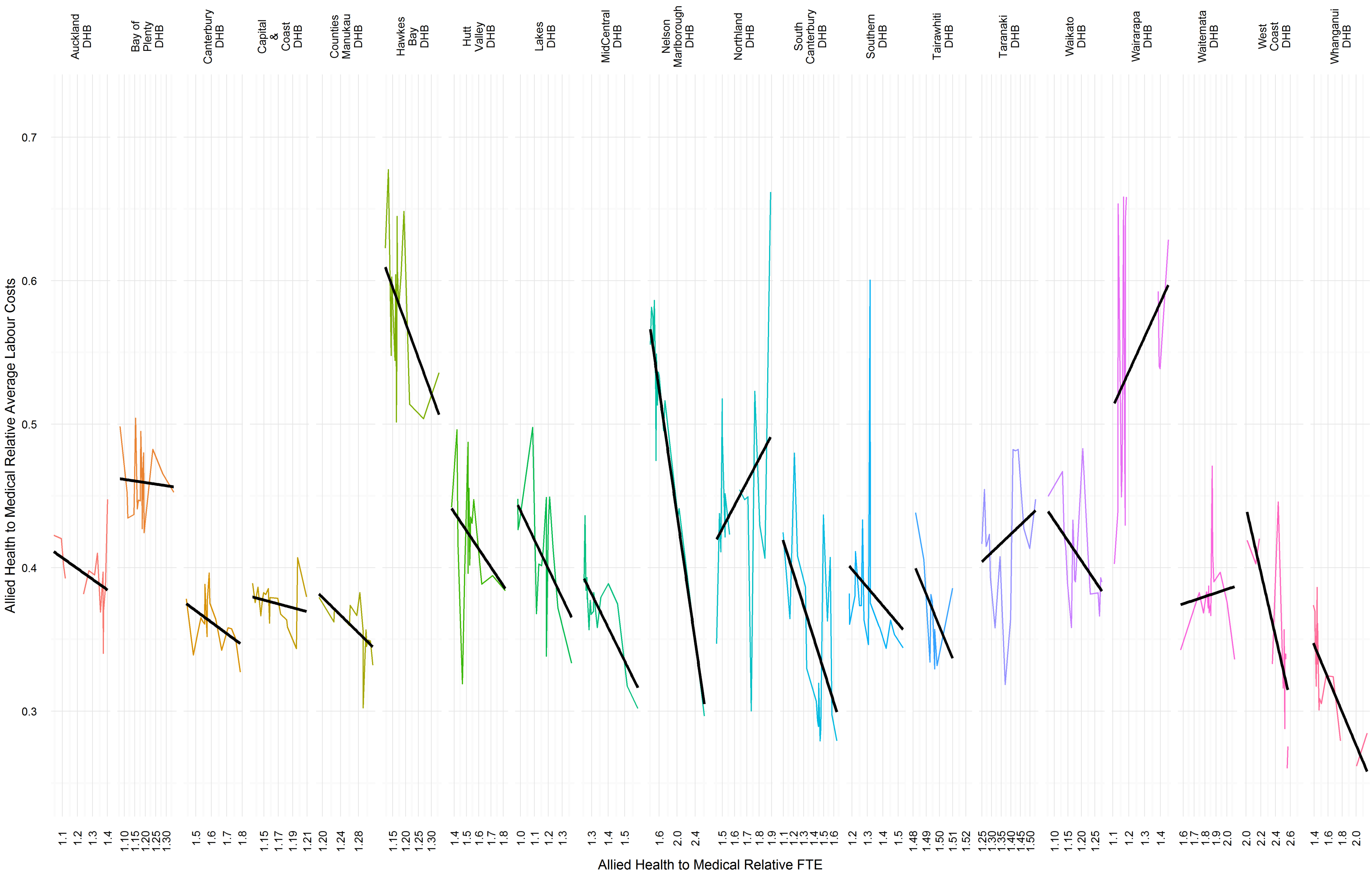


Figure 1: DHB Labour Price / Employed Quantity Workforce Relativities: Nursing

Figure 2: DHB Labour Price / Employed Quantity Workforce Relativities: Allied Health



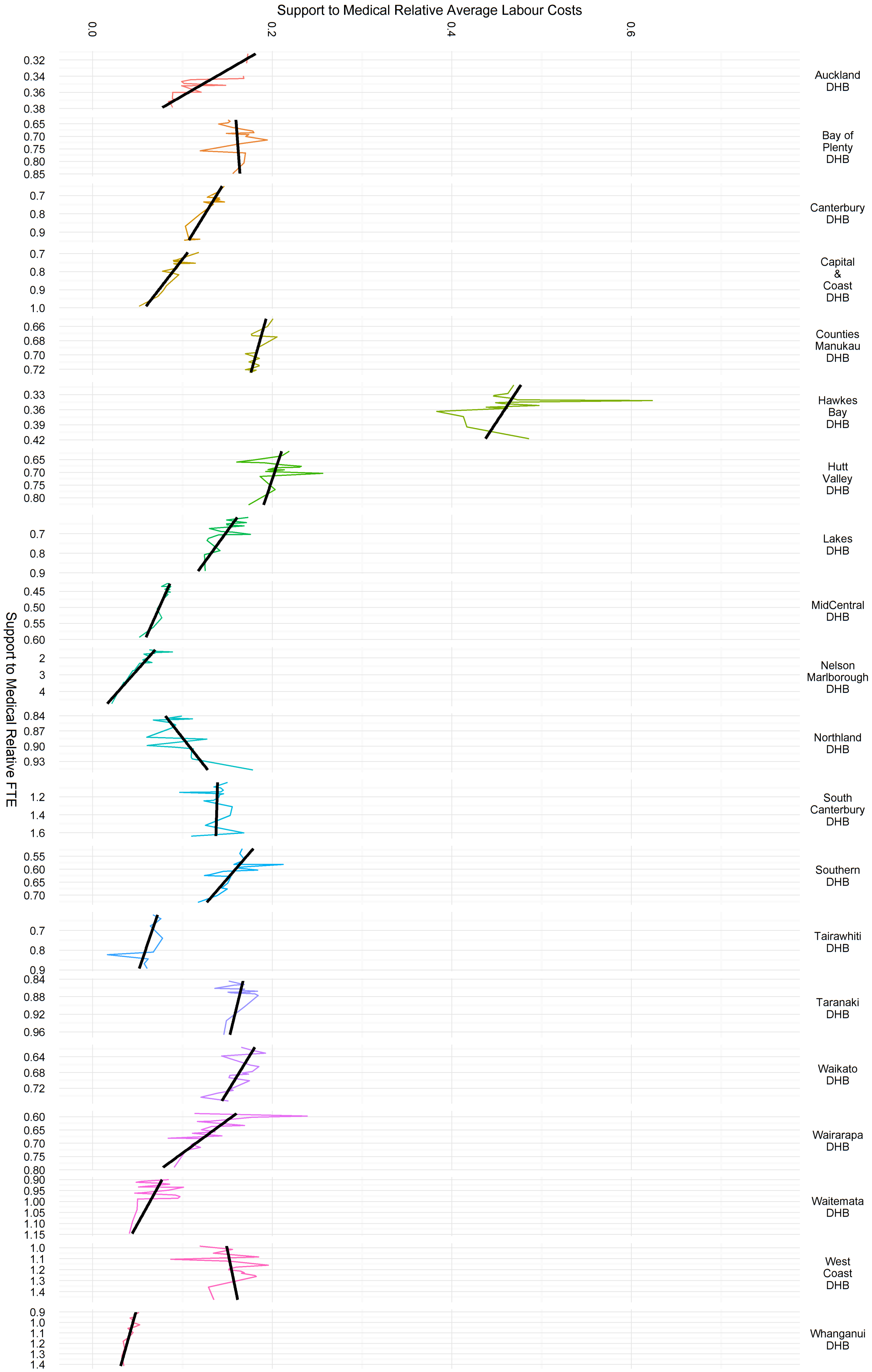


Figure 3: DHB Labour Price / Employed Quantity Workforce Relativities: Support

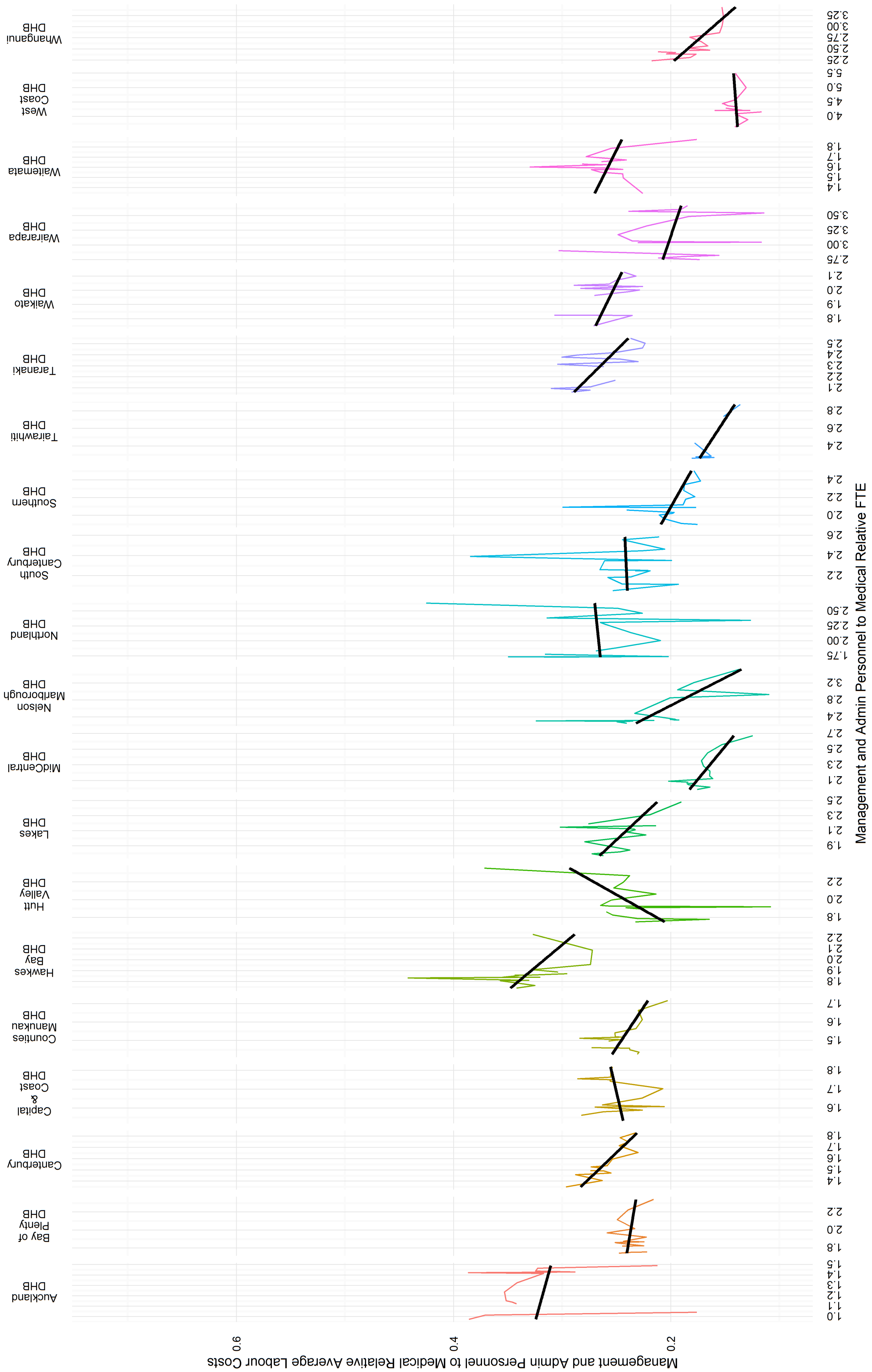


Figure 4: DHB Labour Price / Employed Quantity Workforce Relativities: Management / Administration

3 Labour Markets and Unions: Economic Theory

Theory suggests unions expropriate economic surpluses from alternative sources of wealth for the pecuniary gain of their members and, in the process, decrease societal welfare and distort economic efficiency. Unions increase wages, induce firms to hire less labour and employ more capital per worker, or hire higher quality labour than is needed. Unions function as "rent-seeking institutions that use monopoly power to transfer economic surplus from other economic agents to their members".[5]

That perspective is viewed against the counter-factual of the competitive labour market which, union proponents argue, misses a positive non-wage effect: union "collective voice" which offset their "monopoly face".

3.1 The Positive Side of Unions

3.1.1 Collective Voice / Institutional Response

[Freeman and Medoff(1979)] argue unions do not reduce economic efficiency or generate inequality: unions increase worker productivity, and enhance workforce equality. In the absence of a union, workers have one mode for redressing workplace grievances: exiting the employment position. If the labour market is competitive, unfairly treated or under-paid workers can improve their work conditions through moving. Under-paying employers find replacement labour only at the higher competitive market price. A sub-competitive workplace will fail to attract replacement labour into a vacated role.

[Freeman and Medoff(1979)] accept unions raise wages above competitive levels (their monopoly face), but maintain unions generate offsetting non-wage effects (through their collective voice) that, overall, societal welfare is not reduced. Providing workers a voice in both an employment and a political setting, unions improve the economic and social system. Unions engage the employment parties into a political process involving conversations on the problems workers perceive in the workplace. [Freeman and Medoff(1979)] offer four reasons why union collective voice counteracts the negative effects of their "monopoly face".

Employment terms and conditions have quasi-public-good aspects to them. All employees

[5] [Kaufman(2004)] on page 353

are affected by their employment conditions but free-rider issues prevent individual workers initiating change. The benefits of the corrective action accrue to the collective while the costs of correction are borne by the individual. Unions, representing the collective, are best placed to lead workplace and employment change and spread correction costs over all workers that benefit.

Secondly, employees who remain in employment roles are unlikely to voice their concerns. A power imbalance between employees and employers means disgruntled workers who remain in their roles lose their ability to voice their displeasure. Without the ability to leave, employees choose not to complain through fear of employer retribution. Unions dilute managerial authority and allow workers an ability to object to managerial decisions.

In competitive labour markets, employment terms and conditions are set at the margin by the behaviour of workers who are prepared to exit/enter an employment role. These tended to be younger, more mobile workers, resulting in employers focusing on their interests. The interests of the "infra-marginal" worker who stays are overlooked. "Infra-marginal" workers tend to be older members of the workforce. Unions consider the interests of *all* the workers, not just those willing to leave. As political institutions with elected leaders, unions respond to different signals than those of the competitive labour market.[6]

Finally, unions improve workplace productivity, reduce workforce churn, and lower employer costs from exiting and entering employees. Under unionism, promotions become less dependent on individual performance and more related to other aspects like seniority. The workforce are more likely to act co-operatively and promote collective-learning. Unions force employers to respond to union demands whilst maintaining profitability, encouraging management to remove any X-inefficiency within the firm's production processes. That level of stimulation may not exist within a non-unionised workforce.

3.2 The Monopoly Face of Unions

[Kaufman(2004)], publishing twenty five years after [Freeman and Medoff(1979)], focused on union-related microeconomic theory. Most economists view unions as akin to a labour market monopoly, which like enterprise monopolies in productive markets, are no less desirable because they raise prices above the competitive level which would prevail in the absence of the monopoly.[7]

[6] [Freeman and Medoff(1979)] on page 6
[7] [Kaufman(2004)] on page 351

A union's monopoly face generates price distortions that induce an inefficient mix of factors-of-production, and a misallocation of resources between unions and the non-union sector.[8]

Figure 5: Labour Market Economic Theory: Graphic

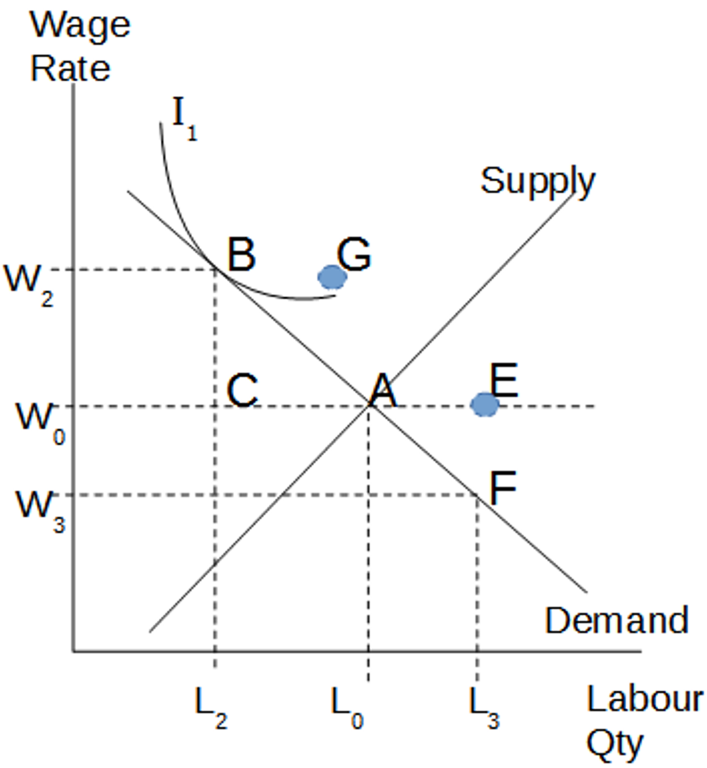


Figure (5) graphically summarises the union-related labour market economic theory. In a competitive labour market, the interaction between labour supply and demand would result in a quantity of labour, L_0, employed at a price (wage rate) of W_0. A union, if successful in obtaining members and organising the workforce, gains market power over the supply of labour which it uses to increase union member's collective utility.

In the theoretical model, member utility is a function of their labour wages and the number of employed persons within the labour market. In Figure (5), the union expresses its member's preferences through the indifference curve I_1 which reflects the trade-off between higher wages (W_2) and employed roles (L_2). If the union's activities are successful, both industry wages increase and induced labour unemployment is minimised.

The effect of less employed labour is a reduction in the volume of goods and services produced within the output market. If industry output actually contracts through firms closing down, some union members directly bear the cost of the higher wage gains achieved by other union members

[8] [Kaufman(2004)] on page 352

through becoming unemployed. However, if industry contraction can occur through dissuading new firms from entering a shrunken output market, then employment and production losses are borne by hypothetical firms who *could have* entered a competitive market and employed labour up to the competitive market equilibrium.

Restricting the *potential* for the labour market and output markets to expand is the ideal outcome for unions: none of their existing voting members are affected by the union's monopoly face, and all enjoy the benefits of higher wages. However, the cost of the union wage and employment distortions are borne by new or prospective labour market entrants and consumers. New labour market entrants are excluded from employment by the lower production and employment opportunities in the unionised industry. Consumer consumption choices are restricted by less quantity of goods/services available, or less choice of supplier from whom they can choose. Consumers may also face higher output good/service prices.

The increase in labour costs increases the cost-of-production for all unionised firms within the industry. If production cost increases are passed on to consumers, then whether consumers or producers "bear" the burden of cost increases depends on the relative output market demand and supply price elasticities. Producers will have difficulty passing on cost increases if output demand is price-elastic. Producer profitability will decline, and producers will exit the industry. If output demand is price-inelastic, consumers bear the union labour cost increase through higher output prices.

A decrease in producers also results in fewer employment opportunities opening up within the unionised workforce. Over time, the range of employment opportunities becomes limited to fewer employers who can afford the higher unionised wage rates. The labour demand curve in Figure (5) "flattens" and becomes more sensitive to price changes. If higher labour costs are maintained, the employed workforce further declines.

3.2.1 Labour Supply and Price-Signalling Effects

If unions have been successful in increasing wages to W_2, W_2 intersects with labour supply at L_3. The unionised wage "attracts" L_3 entrants into a labour market whose employment is constrained to a lower L_2 level. Excess demand is created for unionised jobs and positions within the industry. Unsuccessful workers queue for union jobs, remaining unemployed until a vacancy opens, leave the labour market altogether, or migrate to the non-union sector and search for employment there.

If non-unionised firms exist within the industry, and unsuccessful workers do migrate to non-unionised firms, the L_3 labour supply exerts downward pressure on non-unionised wages. *If* wages *are* flexible in the non-unionised firms, the excess labour supply $(L_3 - L_2)$ is employed at a below-competition wage rate, W_3, by non-unionised producers. Non-unionised producers not only face lower wage prices, compared to their unionised competitors, but sell their output goods/services at the higher-than-competitive output price of their unionised competitors.

If both union and non-union employers have similarly skilled workforces, the lower wage, W_3, received by the non-unionised workforce creates workforce inequality between workers. Consequently, non-union employers receive a windfall advantage as their costs-of-production are significantly lower than unionised employers. Non-union employers also enjoy less price competition from unionised employers who have higher costs-of-production.[9]

3.3 Rent-seeking and Incident of a "Union Tax"

Unions produce a dead-weight loss that can be modelled as a"union tax".[10] Like taxes in general, "a tax will raise more revenue the more inelastic (less price sensitive) is the demand for the good being taxed and the less opportunity economic agents have to evade it."[11]

An inelastic employer demand for labour is crucial for union long-term success. The more inelastic the demand for labour, the smaller the loss in employment for any given union wage increase and the greater the potential increase in wages for union members. The less price-sensitive consumers are in the product market, the less wage-sensitive producers are in the labour market. If firms can 'pass-through' cost increases to consumers, employers are more willing to concede to union labour demands, and consumers ultimately bear the cost of the union tax.

Union monopoly power is maximised if the entire output market is price-inelastic. Firms within a monopolistic, or oligopolistic industry who have market power can pass on price increases to consumers. "Non-market" Government-supplied output markets are similar to monopoly provider output markets, since the entire industry responds to the funding signals of a single

[9] [Kaufman(2004)] on page 353
[10] Triangles (A-B-C) and (A-E-F) in Figure (5).
[11] [Kaufman(2004)] on page 354

revenue source and decision-maker. Consumers lack substitutes to the government-provided service and the output product market is price-inelastic.

If product markets were competitive, the ability for unions to raise wages and other labour conditions above market levels would be very limited. Competitive product markets imply firms are only generating competitive rates of return on capital. If unions try to increase labour's rate of return, firms will close as capital seeks higher returns elsewhere with resulting union member unemployment.

3.4 Source of Surplus Value for Expropriation

When product markets are imperfectly competitive, the prospects for successful union rent-seeking significantly increase, particularly amongst regulated industries. Unions are able to tap into the super-normal rent aspect of industry production, leaving the competitive rate-of-return untouched for capital remuneration. Even if the product market is competitive, unions may seek to increases wages and labour costs over competitive levels and extract economic surplus.

Union monopoly effects can persist if labour cost increases are accompanied with productivity increases. Increased productivity generates a surplus from which higher labour costs can be funded, leaving capital to be remunerated at its competitive level. Surplus value, derived from productivity gains, can be entirely directed by unions towards their members.

Secondly, if the adjustment horizon over which firms can exit and enter a market is long, unions may extract surplus while firms exit a market over a prolonged period. If a firm has high capital asset-specificity, making exiting a market difficult to practically implement, unions can exploit the long adjustment periods to extract returns over a "short term", which may last several years.

Thirdly, [Kaufman(2004)] notes that if some firms have lower cost structures than others, or a non-reproducible factor-of-production which secures them an economic advantage (like an advantageous physical location), then that source of surplus is available for unions to extract. Surplus value from innovation or novelty becomes captured by the workforce.

The nature of the production technology may make producers labour-price insensitive and create inelastic labour demand. If labour, capital and other inputs in the production process have a low elasticity of substitution, producers face difficulty replacing unionised labour with alternative cheaper inputs. Producers with low input substitution elasticities have an inelastic labour demand curve that can be exploited by unions.

Reducing the production input substitution elasticity may be a deliberate union strategy. Entrenching specific roles, workforce mixes, or maintaining specific role demarcations reinforce/entrench union power through deliberately reducing labour's substitutability.[12]

If the elasticity of substitution is low, producers and the non-unionised workforce bear the cost of the "union tax".

3.5 Cost of Unionisation

Positive economics perceives unions negatively through the inefficiencies and distortions to production which they introduce. Competitively determined relative prices lead to an efficient allocation of resources across firms and industries. Competitive markets are Pareto efficient: it is impossible to reallocate resources so as to make any economic agent better off without simultaneously making another worse off. When unions increase labour costs, they distort input price relativities leading to a misallocation of resources between alternative uses, creating inefficiencies in production, and generating dead-weight social welfare losses.[13]

3.5.1 Loss of Allocative Efficiency

Allocative efficiency between industries requires input market prices equating to industry-based marginal-input-productivities. Competitive market prices direct labour towards industries with higher labour productivity. If identical labour has higher marginal productivities within one industry over another, then allocative efficiency requires labour to migrate between industries and reflect the high productivity in one industry over the other. If productive resources do move to reflect marginal productivity differences, then social welfare increases as more output is generated from the same inputs used in production.

Union monopoly power distorts labour market prices, misallocating labour resources between industries. Unions that increase wages attract "too much" labour into a unionised industry's labour market ($L_3 - L_2$ in Figure (5)), implying another industry exists that has "too little" labour for its industry's marginal labour productivity.

[12][Kaufman(2004)] page 355
[13][Kaufman(2004)] at p355

Maintaining wages artificially high at W_2 attracts a higher *quality* of labour into the industry than is otherwise needed from a competitive market. Highly skilled labour which *could* earn W_2 competitively in other industries are instead drawn into the unionised industry by the higher-than-competitive wage signals artificially generated by unions. Workers with adequate skills and capability to deliver L_0 service at W_0 are excluded from the employment market by the calibre of workforce attracted into the labour market by the higher unionised wage.

If unions successfully increase labour costs over their competitive levels, then the capital/labour price relativities become distorted. Ironically, capital becomes "too cheap" compared to labour. The higher relative labour-per-capital cost induces firms to invest in more capital than needed compared to the competitive market. Unions unambiguously decrease labour, but capital investment may increase as firms seek to maintain production levels.

3.5.2 Loss of Technical Efficiency

Technical efficiency occurs when the maximum possible output is produced from a given combination of inputs. Technical efficiency implies cost-minimisation and the absence of organisational slack. Unions reduce technical efficiency through advocating non-cost-minimising policies and processes that confer benefits to their members not otherwise achievable through a technically-efficient competitive market.[14]

Some of the technical-efficiency-reducing union practices identified in the literature include the following:

- "Feather-bedding" / make-work rules

  Feather-bedding occurs when excess labour is employed to perform a given role or task. The phrase originates from the American railway unions who, facing changing technology, sought to preserve their jobs through negotiating contracts requiring employers to pay workers for doing little or no work, or which involved complex and time-consuming work rules that generated a full day's work for an employee who otherwise would have been made redundant.[15]

- Narrow role delineation

  Narrow job descriptions that split up tasks into multiple spheres of responsibility across

[14] [Kaufman(2004)] on page 356
[15] http://en.wikipedia.org/wiki/Featherbedding

separate trades or occupations decrease technical efficiency. Narrow role descriptions decrease the elasticity of substitution for employment roles through increasing the interdependency of different roles on each other. Narrow roles expand the workforce and the potential for increased union membership.

- Promotion /Disciplinary restrictions

  Union seeking to de-couple employment promotion processes from the recognition of an individual's labour productivity, reduce technical efficiency through disconnecting remuneration from the workforce's marginal revenue product. Conversely, disciplinary restrictions that prevent employers correcting issues relating to an individual's conduct, their productivity, their performance of their role, or the risks they create reduces technical efficiency.

3.6 Median Voter Models of Union Behaviour

Unions do not "own" labour: they negotiate a labour price with employers that both workers and employers agree to honour. A union operates more like a cartel of individual producers who join together to set a monopoly price for their services.

The Median Voter (MV) model is one description for how union's reconcile the preferences of individual union members into a coherent bargaining strategy. The MV model assumes union leaders choose bargaining options which are put to a democratic vote by the union members. A simple majority is needed for any one option to become the preferred bargaining position for employer negotiation. The MV model theorises the outcome of a democratic vote will reflect the "median voter's" preferences and collective interests.

Median voter models introduce an element of democracy into union negotiations: the union's bargaining position reflects the view and interests of their collective members. The adoption of a democratic voting process that expresses the 'will of the majority' obscures union rent-seeking activity. Union demands are the outcome of a democratic process, and are more likely to be perceived as reflecting a genuine desire to redress a "legitimate" employment grievance affecting the collective, rather then the transfer of economic surplus from other economic agents to a self-interested employed workforce.

3.6.1 Insider-Outsider Collective Coercion

An implication of the MV model is that unions not only redistribute income from consumers, firms and non-union workers to union members, but they also redistribute income amongst the union members themselves. As unions bargain, some members gain more than others. Consequently, the aspects which union's negotiate over reflect, in part, the internal dynamics of the union: an insider-outsider form of coercion against minority interests.

One MV voter preference structure discussed in the literature focuses on member preferences that systematically differ by member employment *seniority*. If low-seniority union members differ in their employment expectations from high-seniority members, then the negative unemployment effects of the union monopoly face may disproportionately impact junior union members if the "median voter" is more like senior members than junior members. The higher wage expectations of senior members disproportionately shape the union's collective wage demands, but the job losses from the high demands disproportionally fall upon the junior members.

3.6.2 Bargaining Positions as Expressions of Union Political Dynamics

[Kaufman(2004)][16] notes that the bargaining positions presented by unions themselves can reveal aspects of the internal politics within the union. Bargaining positions that include minimum work-sizes or other aspects that are "make work" are likely not to be important for unions with expanding membership compared to unions whose members risk displacement through new technology. Similarly, a union is likely to reject employer demands for a pay cut, unless the threat of job losses are so large that agreeing to the cut is in the member's best interests.

Insider-outsider collective dynamics have important implications for graduates without experience or graduates looking to enter the market place. As non-members of an existing union, their preferences, more aligned to the competitive W_0, do not feature in the union's "preference set" when formulating bargaining positions. The interests of prospective entrants into a labour market find no expression in a unionised industry, which neither offers them employment on competitive terms and conditions, nor access to unionised employment which reflects the interests of currently employed members.

Inside unions, voting coalitions can form which may attempt to use collective decision-making

[16] On page 362

democracy to redistribute union gains to their coalition members and away from minority interests outside the coalition. For example, wage standardising and wage levelling are an outcome which moves the majority of the union wage-gains towards the lower end of the member spectrum at the cost of members in the higher end whose wage-rates are reduced. Likewise, rather than focusing on performance-related remuneration structures, unions reflect the interests of members who are less likely to leave for more competitive conditions. For incumbents, a non-performance related remuneration package reflecting automatically obtained employment benefits like health insurance, pensions, or child-care packages reflects their preferences and becomes the union bargaining position through the MV model.

3.7 Countering Monopsony Employment Power

Unions can be an effective counter to employer *monopsony* power. Monopsonistic employment conditions occur when a single firm, or a cartel of firms, become single monopoly purchasers of labour. While a *monopoly* increases prices in output markets above their competitive position, *monopsonists* use their single employer market power to *lower* labour prices below their market position, where competitive prices would have been set by labour's marginal revenue product. Under this scenario, union monopoly power can act as an effective counter-balance to the employer monopsony power, prevent worker exploitation and move the employment level and wages towards a more competitive market position.

[Kaufman(2004)] argues most economists believe labour markets have become more competitive over time, with increased labour geographic mobility, improved job information, and a larger number of employers within local areas. The "classic" one-company-town monopsony employer is seen as a historical curiosity. Other sources of worker "lock in", like job knowledge specificity or training, are seen as not only tying the workforce to the employer, but also tying the employer to the workforce creating an effective *bilateral* monopoly.

4 DHB Health Service Output and Input Measurement

This thesis estimates a gross output, national-health-expenditure based-weighted composite Laspeyres activity-based health-service output index. The source financial and health-service output data was obtained from the MoH through an Official Information Act request, and reflects MoH definitions and terminology.

The “commodities” within the output index are Major Service Group (MSG) level estimates of health service output volumes. The base-weights used to combine the MSG commodities together are national health service expenditure shares for each MSG derived from estimates of total MSG health expenditure in the 2011 financial year. The MSG group commodities are themselves sub-indices derived from cost-weighted activity-based output measures for services within each MSG.

Algebraically,

$$L_{(Output)} = \sum_{i=1}^{n} \left(\frac{q_i^t}{q_i^0} \right) S_i^0 \qquad \text{where} \qquad q_i^t = \frac{\sum_{m=1}^{r} c_m^0 h_m^t}{\sum_{m=1}^{r} c_m^0 h_m^0} \tag{1}$$

$$\text{and} \qquad S_i^0 = \frac{v_i^0}{\sum_{i=1}^{n} v_i^0} \tag{2}$$

Where:

q_i^0, q_i^t are output volume indices in periods 0 and 1 of i = 1,.,n MSG output volume indices.

c_m^0 is the base period health-service prices, derived from either the DHB Production Plans or PUC price estimates for inter-DHB transfer pricing.

h_m^0, h_m^t are activity-based volumes measures in periods 0 and 1 of m = 1,.,r homogeneous PUC health-service commodities.

$v_i^0 = p_i^0 \times q_i^0$ where p_i^0 is a national estimate of health expenditure spent for each MSG-based estimate of q_i, and S_i^0 represents the health expenditure share for each MSG within the base year.

As a consequence of the relationship between total value and volume output measures described in equation (10), equation (3) describes the implicit Paasche price index which is the dual price measure to the output measure defined in equation (1).

$$P_{price} = \frac{I_v}{L_{(Output)}} \tag{3}$$

Equation (3)'s Paasche price index represents the underlying price change associated with changes in DHB Provider Arm output and DHB Provider Arm total expenditure. It is an implicitly derived measure of DHB Provider Arm output cost inflation.

4.0.1 The National Service Framework

The National Service Framework[17] (NSFW) describes health-service commodities. The MoH and DHBs maintain the NSFW as part of the accountability requirements between the MoH and DHBs.[18] The NSFW describes health services according to a well-defined and well-managed health-service commodity classification system that standardises the description of health-service activities into "Purchase Unit Codes" (PUC).[19] PUC measurement definition and quality is maintained through a set of nationally agreed Common Counting Standards for PUC measurement and reporting.[20]

4.0.2 DHB Provider Arm Production Plans

DHBs are required to submit annual Production Plans to the MoH that reflect the volume and type of health-services they intend to purchase from either their Provider Arm or through their Funder Arm, and the per unit price they intend to pay for each PUC component of planned health care.[21],[22] Each health-service PUC "price" is a price in the economic sense since it represents an exchange of value in return for the provision of health services to the DHB's local population. However, in practice, Production Plan "prices", especially for health-services purchased from the DHB's Provider Arm, tend to reflect the Provider Arm's costs of health care delivery rather than the outcome of an arms-length transaction between two separate parties negotiating for the provision of health care.

[17] http://www.nsfl.health.govt.nz/apps/nsfl.nsf/menumh/Home

[18] http://www.nsfl.health.govt.nz/apps/nsfl.nsf/menumh/Accountability+Documents

[19] http://www.nsfl.health.govt.nz/apps/nsfl.nsf/pagesmh/462

[20] http://www.nsfl.health.govt.nz/apps/nsfl.nsf/pagesmh/463/$File/Common+Counting+Standards+2012+2013.pdf

[21] http://www.nsfl.health.govt.nz/apps/nsfl.nsf/menumh/Accountability+Documents

[22] http://www.nsfl.health.govt.nz/apps/nsfl.nsf/pagesmh/200/$File/Production+Plan+2013-14+template_v2_Dec12.xlsx

4.0.3 Weighted Inlier Equivalent Separation (WIES) units of measure

A significant number of PUCs are defined in terms of "Cost Weighted Discharges", a term synonymous with "Case Weighted Discharges" or "Casemix Funded Events". In contrast, "Cost Weights" are a set of service-based weights derived from historical patterns of patient expenditure stratified by patient age, sex, ethnicity and NZDep2001 characteristics, and used in the Population Based Funding Formula for funding DHBs.[23] To avoid confusion, the term "Case Weighted Discharges" (CWD) will be used throughout this thesis to refer to WIES units of measure.

A CWD is a health-service unit of measure based on the Australian Victorian State's system of Casemix funding first introduced by the Victorians in 1993. Casemix funding has an extensive history in both Australia and New Zealand, and although no longer used to fund New Zealand DHBs, in Australia, Casemix funding has recently expanded in scope and defines a component of all Australian public hospital funding.[24] The methodology shares significant intellectual parallels with the United Kingdom's Pay by Results approach to funding its National health-service.[25] Since its first introduction in 2000, New Zealand has developed and expanded the WIES methodology to reflect differences between the New Zealand and Victorian health systems.[26]

Case weighted discharges are a resource-based volume measure derived from the WIES methodology that measures the relative resources used in the delivery of inpatient heath care. The WIES methodology defines health services according to an international classification of patient disease-related diagnosis and treatment. The classification that governs the description of Diagnostic Related Group (DRG) health-service commodities in New Zealand is the Australian Modification of the World Health Organisation's International Classification of Diseases (ICD-10-AM).[27] In New Zealand, every publicly-funded inpatient event is clinically coded to its relevant ICD-10-AM codes reflecting both the patient's diagnosis and treatment. The coded events are grouped into larger clusters of activity that are diagnostically related to form DRGs.[28]

Each DRG receives a "case weight" that represents the proportion of a "unit price" needed

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[23] http://www.moh.govt.nz/notebook/nbbooks.nsf/0/dd8c56491558f0fbcc256e8f007e566d/$FILE/PopulationBasedFundingFormula
[24] http://www.ihpa.gov.au/internet/ihpa/publishing.nsf/Content/about-us
[25] http://www.dh.gov.uk/health/category/policy-areas/nhs/resources-for-managers/payment-by-results/
[26] http://www.health.govt.nz/nz-health-statistics/data-references/weighted-inlier-equivalent-separations
[27] http://meteor.aihw.gov.au/content/index.phtml/itemId/360927
[28] http://www.health.govt.nz/nz-health-statistics/data-references/code-tables/common-code-tables/drg-code-table

to compensate health-service providers for care. For example, in 2012, WIESNZ12 estimated that DRG "A05Z - Heart Transplant" health services consumed approximately 31.6 CWDs per inpatient event.[29] On average, Heart Transplant patients were admitted for approximately 43 bed days. In comparison, the treatment of DRG "F74Z - Chest Pain" consumed approximately 0.36 CWDs per inpatient event and patients were, on average, discharged after slightly over 1 day. Consequently, Heart Transplant patients consume approximately 8,678 percent more health resources than Chest Pain patients. In 2012, the unit price per CWD was $4,614.36. As a result, on average, Heart Transplants cost DHBs $145,814 per inpatient event. Chest Pain patients cost $1,661 per inpatient event.

4.1 Aggregating Volumes Across Dissimilar Health Services

Most health-service providers produce a range of health-service commodities. Within the NSFW, the Medical MSG alone identifies 212 different PUCs. Even a comparably small MSG, like Disability Support Services, has approximately 100 distinct PUC health-service commodities. Measuring Provider Arm output requires distilling the information content from the hundreds of different health-service commodities into a single unitary output measure that reflects the size and breadth of health-service volume changes occurring between periods.

Much of the value providers receive in exchange for health-services is supplied by the Government on behalf of New Zealanders. DHB health care is free for New Zealand residents. "De-coupling" health care services from patient payments for care is what defines the health-sector as a "non-market" industry. However, the lack of an objectively determined price between producers and consumers hampers the formation of an output measure since there are no output service valuations patients objectively place on the health care they receive from DHB Provider Arms.

4.1.1 DHB Production Plan Prices as Substitutes for Market Prices

DHB Production Plans require DHBs to describe a purchase price they intend to pay for health-services, either from their Provider Arm directly or from private provider's funded through the DHB's Funder Arm. While the Production Plan price reflects an estimate of the health-service's cost it does link DHB total funding budgets to health-service purchasing decisions.

[29] http://www.health.govt.nz/system/files/documents/pages/wiesnz12-use-with-ar-drg-6-0-adapted-nz.xls

Production Plan prices are not the outcome of an arms-length market transaction between the DHB's Funder and Provider Arms. However, they do reflect a trade-off DHBs make between different types of health-services that are affordable from their budgets. Despite the absence of an output market, DHB Production Plan prices reflect resource scarcity and influence DHB purchasing decisions.

4.2 Price and Volume Index Theory

A price index is a weighted average of the changes in prices for a specific set of goods and services between two periods of time. Similarly, a volume index is a weighted average of the proportionate changes in the volumes of a set of goods and services between two periods of time. The two most commonly used index formulae are the Laspeyres and Paasche indices which together share a unique relationship that can be exploited for applied health-sector economic analysis.

A Laspeyres *volume* index is:

$$L_Q = \sum_{i=1}^{n} \left(\frac{q_i^t}{q_i^0} \right) s_i^0 \equiv \frac{\sum_{i=1}^{n} p_i^0 q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^0} \tag{4}$$

Where p_i^0 , q_i^0 and $v_i^0 = p_i^0 \mathrm{q}_i^0$ are the prices, quantities and payment values in period 0 of i = 1,.,n health-service commodities. p_i^t , q_i^t and v_i^t are similarly defined for period t, and

$$s_i^0 = \frac{v_i^0}{\sum_{i=1}^{n} v_i^0} \tag{5}$$

represents the value shares of commodity i in period 0.

A Paasche *price* index is:

$$P_P = \left[\sum_{i=1}^{n} \left(\frac{p_i^t}{p_i^0} \right)^{-1} s_i^t \right]^{-1} \equiv \frac{\sum_{i=1}^{n} p_i^t q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^t} \tag{6}$$

The Paasche price index in equation (6) reflects the change in the value of a basket of health-service commodities whose prices change in different periods, weighted in each year by the quantities purchased in the current period base period.

Both Laspeyres and the Paasche indices are "base weighted" indices with the Laspeyres index setting the earlier period as the base period and the Paasche index setting the later period as the base period. Between two periods, the total change in the value of all health-services purchased in each year is:

$$I_v = \frac{\sum_{i=1}^{n} v_i^t}{\sum_{i=1}^{n} v_i^{t-1}} \tag{7}$$

Equation (7) is a total value measure, and reflects the combination of changes in health-service volumes and changes in health-service prices between each period.

When Laspeyres and Paasche indices are used, the change in total value calculated in equation (7) will exactly decompose into a price index multiplied by a volume index such that:

- A Laspeyres price index together with a Paasche volume index will exactly equal the change in total value:

$$L_P \times P_Q = I_v \tag{8}$$

- A Laspeyres volume index together with a Paasche price index will also exactly equal the change in total value:

$$L_Q \times P_P = I_v \tag{9}$$

The relationship between Laspeyres indices, Paasche indices and total value measures implies only two of the three measures need to be known before the third can be derived. If both a Laspeyres volume index and total value measure are known, then together they implicitly define a Paasche price index as a dual price measure:

$$P_P = I_v / L_Q \tag{10}$$

Equation (10), which establishes a price relationship between changes in value and changes in quantity, can be used to derive a price inflation measure which represents either a Laspeyres or a Paasche counterpart index for the explicitly measured volume index. If the explicitly measured quantity index has significant data coverage, it can be used in conjunction with measures of total health expenditure, total labour cost, or total economic capital spent, to derive an implicit cost price inflation measure which is the counterpart to the quantity index.

Equation (10) is used extensively within this thesis to estimate aggregate labour costs, total health-service cost inflation and to derive an implicit estimate of changes in total capital consumed within the production process.

5 Data Sources and Methods

The majority of information used within this thesis comes from the MoH's DHB monitoring sources. The MoH collects monthly data on DHB balance sheet, and profit and loss position. At the end of each financial year, the monthly measures are aggregated into national-level MSG estimates of health-service expenditure. Figure (10), at the end of this section, graphically present the DHB health service output measures for each DHB Provider Arm.

MoH data was used to create the health-service output measures used for production analysis. Through its role as custodian of the National Data Collections[30], the MoH collects a vast array of health-service delivery information. Not all the information is immediately suitable for economic analysis. Section 5.2 describes how output measures were derived from detailed low-level source information, predominately from the National Collections.

5.1 Financial Information

5.1.1 Ministry of Health DHB Monitoring Data

Profit and loss, and balance sheet data was sourced from monthly information collected by the MoH as part of the monitoring function it undertakes as agent for the Minister of Health.[31] The MoH uses the monthly information to create reports for the Minister of Health on DHB financial performance.

At the end of every financial year, the MoH compiles the monitoring information into an estimate for the value of expenditure spent across different MSG health-services. Unlike the monthly DHB profit and loss monitoring reports, that reflect health expenditure spent on inputs to production, the DHB national health expenditure monitoring information considers health expenditure by MSG output area. Table (2), derived from the annual expenditure estimates, shows how DHB Provider Arm expenditure for different MSGs has changed over time.

[30] http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveysmega=Health%20statistics&title=National%20co

[31] http://www.health.govt.nz/new-zealand-health-system/key-health-sector-organisations-and-people/district-health-boards/accountability-and-funding/summary-financial-reports

Financial Year	DSS	Maori Health	Maternity	Medical	Mental Health	Neonatal	Outpatients	Paediatrics	Public Health	Remainder	Surgical
2004	131,423	869	113,763	425,977	561,227	54,262	318,251	357,037	-66	1,185,873	539,934
2005	182,722	611	123,061	445,146	597,205	49,284	364,346	73,405	4,023	1,610,235	611,159
2006	193,519	1,006	126,201	490,180	635,064	54,002	387,012	77,635	9,185	1,806,643	661,578
2007	169,812	670	123,992	526,935	693,063	57,823	443,395	89,913	1,683	1,975,921	712,140
2008	220,999	1,243	144,922	648,047	743,477	66,732	506,603	104,358	3,592	1,945,941	878,262
2009	240,407	3,937	201,693	929,227	794,349	110,649	807,151	200,283	12,963	1,071,771	1,376,316
2010	274,603	2,861	255,842	1,082,949	844,854	126,877	812,310	220,022	12,456	1,064,032	1,538,055
2011	279,844	4,909	274,100	1,138,656	861,871	126,044	855,782	230,089	22,246	1,026,095	1,656,700

Table 2: DHB Provider Arm Health Expenditure Over Time ($000)

5.1.2 The Base Period

The 2011 financial year was chosen as the base period for estimating MSG health expenditure base-weights for a health-service output index. Table (2) expenditure measures for 2011 were chosen as the expenditure weights s_i^0 in equation (5).

Laspeyres-based health-services quantity indices were derived for all of the MSG commodities in Table (2). The health-service expenditure weights in Table (3), derived from Table (2) for the 2011 base year, were used to combine the different MSG sub-indices of health-services into a single composite total health-service output index for each DHB. Excluding the “Remainder” group, which lacks robust underlying health-service quantity measures, the derived DHB Provider Arm output quantity index reflects health-service quantity change for 84% of the health expenditure received by DHB Provider Arms.

Financial Year	Major Service Group	2011 Expenditure	Total Provider Expenditure	Output Index Weight
2011	DSS	279,844	6,476,336	0.04321
2011	Maori Health	4,909	6,476,336	0.00076
2011	Maternity	274,100	6,476,336	0.04232
2011	Medical	1,138,656	6,476,336	0.17582
2011	Mental Health	861,871	6,476,336	0.13308
2011	Neonatal	126,044	6,476,336	0.01946
2011	Outpatients	855,782	6,476,336	0.13214
2011	Paediatrics	230,089	6,476,336	0.03553
2011	Public Health	22,246	6,476,336	0.00343
2011	Remainder	1,026,095	6,476,336	0.15844
2011	Surgical	1,656,700	6,476,336	0.25581

Table 3: DHB Provider Arm Health-Service Output BaseWeights

5.2 MSG-Level Output Quantity Measures

The MoH’s Information Group has responsibility for the ”National Collections” of health and disability information.[32] DHB Provider Arm health-services are split between two broad “types” of care: inpatient health-services, where the patient receives care which warrants them being admitted for a minimum of four hours or longer, and “non-inpatient” health-services, where the patient presents at the DHB for care, but is usually discharged from hospital within four hours.

[32] http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections

“Non-inpatient” care is also described as “Outpatient” care.

5.2.1 Inpatient Health Services

The National Minimum Dataset (NMDS)[33] was used as the primary data source for measuring inpatient health-service volumes across different MSGs. WIES version WIES11C[34] CWD measures were used to estimate inpatient DHB Provider Arm health-service volumes for the Surgical, Medical, Maternity, Paediatrics, and Neonatal MSGs.

5.2.2 Non-Inpatient Health Services

The National Non-Admitted Patients Collection[35] (NNPAC) data, processed and cleaned by the National Health Board was used to measure the volume of non-inpatient care delivered by DHBs.

Historically, NNPAC data has suffered from data quality issues.[36] The MoH spent significant effort reconciling NNPAC data with other sources of information to develop as reliable a measure of non-inpatient health-service activity as possible. Unfortunately, reconciling and cleaning NNPAC data results in a loss of time frequency. The non-inpatient data used in this thesis is cleansed annual NNPAC information provided by the National Health Board.

5.2.3 Disability Support Services

WIES CWD measures are not defined for DSS health services. DSS health services were identified within NMDS through testing the first character of the health speciality code.[37] If the first character of the health speciality code within the NMDS patient record was a “D”, then the inpatient event was identified as a DSS event. The length of the inpatient stay was used as the quantity measure for the volume of DSS health service the patient received.

[33] http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/national-minimum-dataset-hospital-events

[34] http://www.health.govt.nz/system/files/documents/pages/wies11c-methodology.doc

[35] http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/national-non-admitted-patient-collection

[36] http://www.stats.govt.nz/browse_for_stats/economic_indicators/productivity/measuring-govt-productivity/8-data-availability-health-care.aspx

[37] http://www.health.govt.nz/nz-health-statistics/data-references/code-tables/common-code-tables/health-speciality-code-table

5.2.4 Mental Health Services

[Paul O'Neil and Minogue(2008)] provides a comprehensive overview of the history of New Zealand mental health funding. Mental health funding systems in the mid-1990s were the outcome of different Commissions of Inquiry. In 1996, the second Mason Inquiry established the Mental Health Commission, which eventually developed and published an input-based funding model known as *The Blueprint for Mental health-services in New Zealand*, or more briefly, *The Blueprint* in 1998. Since then, mental health has always been input funded.

Only recently have mental health output measures been developed. The PRIMHD[38] mental health information collection system collects mental health, health service output measures. The mental health information used in this thesis is one of the initial unpublished attempts undertaken within the MoH to derive a DHB-level mental output series. Like any new statistic, every effort was made to address data quality issues apparent in the data; however, a measure of error undoubtedly exists.

PRIMHD mental health, health-service volume data was mapped to input-based mental health Purchase Unit Codes (PUCs). DHB Production Plan information was used to estimate the amount spent by DHBs delivering different PUC measures of mental health-services. Estimates of the cost per PRIMHD volume were derived for each DHB, and the median cost across all DHBs for each PRIMHD was used as a proxy for an output "costweight", and used to weight changes in PRIMHD volumes to create a mental health output quantity measure. The original experimental series was not released under the Official Information Act request; however, a summarised version of the final results was made available.

Mental health information for the 2013 financial year was unavailable. Information for the 2012 financial year was substituted as a proxy for 2013 mental health output volumes. No information is available to determine whether 2012 mental health volumes under-state or over-state 2013's mental health volumes.

[38]http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/primhd-mental-health-datamega=Health statisticstitle=PRIMHD

5.2.5 Health Service Cost Information

Health-service cost information was used to combine the individual health-services volume measures for each MSG aggregate commodity:

$$q_i^t = \frac{\sum_{m=1}^{r} c_m^0 h_m^t}{\sum_{m=1}^{r} c_m^0 h_m^0} \tag{11}$$

Non-inpatient health-service volumes were weighted together using the "National Price Book" 2013 prices. The "National Price Book" is derived from the joint DHBSS/MoH National Pricing Programme (NPP). NPP collects health-service cost information from DHBs with activity-based health-service costing systems to estimate the average cost of health service delivery for different types of health services. The average costs are used by DHBs as transfer prices for allocating funds between themselves whenever patients are treated outside their resident DHB catchment area. The "National Price" is used to compensate the treating DHB for costs incurred by the non-local patient. Prices in the 2013 financial year were chosen as the weighting for the non-inpatient volumes because they represented the set of prices with the highest coverage of non-inpatient activity for all of the purchase units volume measures obtained from the MoH.

5.2.6 Sub-Annual Volume Interpolation

The different data sources used within this thesis were all reconciled to a monthly time frequency. The NMDS-derived inpatient volumes were supplied on a daily frequency and were aggregated up to a monthly measure. Both the Statistics New Zealand price data and DHB Shared Service's Health Workforce Information Programme (HWIP) labour FTE information were supplied on a quarterly frequency. A linear interpolation method was applied to allocate quarterly price and FTE changes back to the months comprising the quarterly frequency.

The non-inpatient and mental health data was supplied on an annual basis. Deriving monthly estimates required the annual volume estimates to be allocated back to monthly sub-periods using some logical allocation process. Because the inpatient NMDS data was available on a daily basis, its monthly pattern was used to derive proportions of total NMDS activity occurring within each month of each financial year.

The monthly pattern of inpatient health-service delivery, derived from the NMDS data, was used to allocate the annual non-inpatient and mental health data back to months occurring within each financial year. In the absence of any other information for the underlying seasonal pattern occurring within the delivery of mental health or outpatient services, allocating annual measures to months using NMDS ensures DHB Provider Arms retain at least some of the seasonal variation observable from low time frequency data. The price data, used to estimate the quantity of capital consumed in production, was measured on a quarterly frequency and linearly interpolated back to a monthly frequency.

5.2.7 Year-to-Date and Missing Values

The MoH's profit and loss monitoring information was provided as "year-to-date", where each month's values reflect the cumulative totals for the months occurring within the financial period. In order to relate changes in health service quantity to changes in input quantity to changes in costs incurred, the year-to-date expense totals needed to be differenced to derive changes in monthly expenses. Differencing the profit and loss information resulted in some unusual expense movements which may have been omitted from the MoH error checking processes when only cumulative year-to-date totals were being observed.

Some monthly observations for DHBs were missing. For example, Hutt DHB's profit and loss data for December 2012 was missing. Where one month observation was missing from a series with observations on either side of the missing month, the missing month's value was interpolated as the average of the two monthly year to date values on either side, and differenced to estimate the monthly spend for inputs used in production.

5.3 Labour

Labour inputs are measured as a base-weighted Laspeyres volume index, with the 2011 financial year average labour costs for the different workforce groups used as base-weights.

Algebraically,

$$L_{(Labour)} = \frac{\sum_{a=1}^{b} w_a^0 L_a^t}{\sum_{a=1}^{b} w_a^0 L_a^0} \tag{12}$$

Where: w_a^0 is the base period average labour costs for the workforce labour group of a = 1, ., b employed by DHBs. L_a^0,L_a^t are the workforce Full Time Equivalent (FTE) contracted-hour-based labour volume measures for workforce group a = 1, .., b.

The smaller and rural DHBs rely on outsourced labour for delivering health care. The ratio of outsourced labour expense to employed labour expense is notably higher for the West Coast, Wairarapa, Whanganui and South Canterbury DHBs (Figure 6). For these DHBs, outsourced labour may reflect difficulty they face in recruiting workforce to permanent employment positions. I have chosen to treat outsourced labour payments and workforce as an intermediate consumption good. The relationship between contracting DHB and contracted workforce is governed by contract law, instead of employment law. Whether the contract between the DHB and the contracted workforce inherit MECA-like terms and conditions is not directly observable. Consequently, no attempt has been made within this thesis to impute outsource labour workforce volumes and assign their additional value to DHB employed labour measures.

5.3.1 Ministry of Health FTE Monitoring Information

The MoH collects DHB workforce employment measures; however, the relationship between the workforce sizes reported by DHBs and by the MoH has historically been poor (Figure (7)). Figure (7), derived from the MoH's FTE monitoring information, and DHBSS HWIP labour data, presents the FTE workforce estimates from the two sources for common time periods and workforce groups.

The two workforce data sources, if equal, ought to both be projected along the black 45 degree line included in Figure (7).

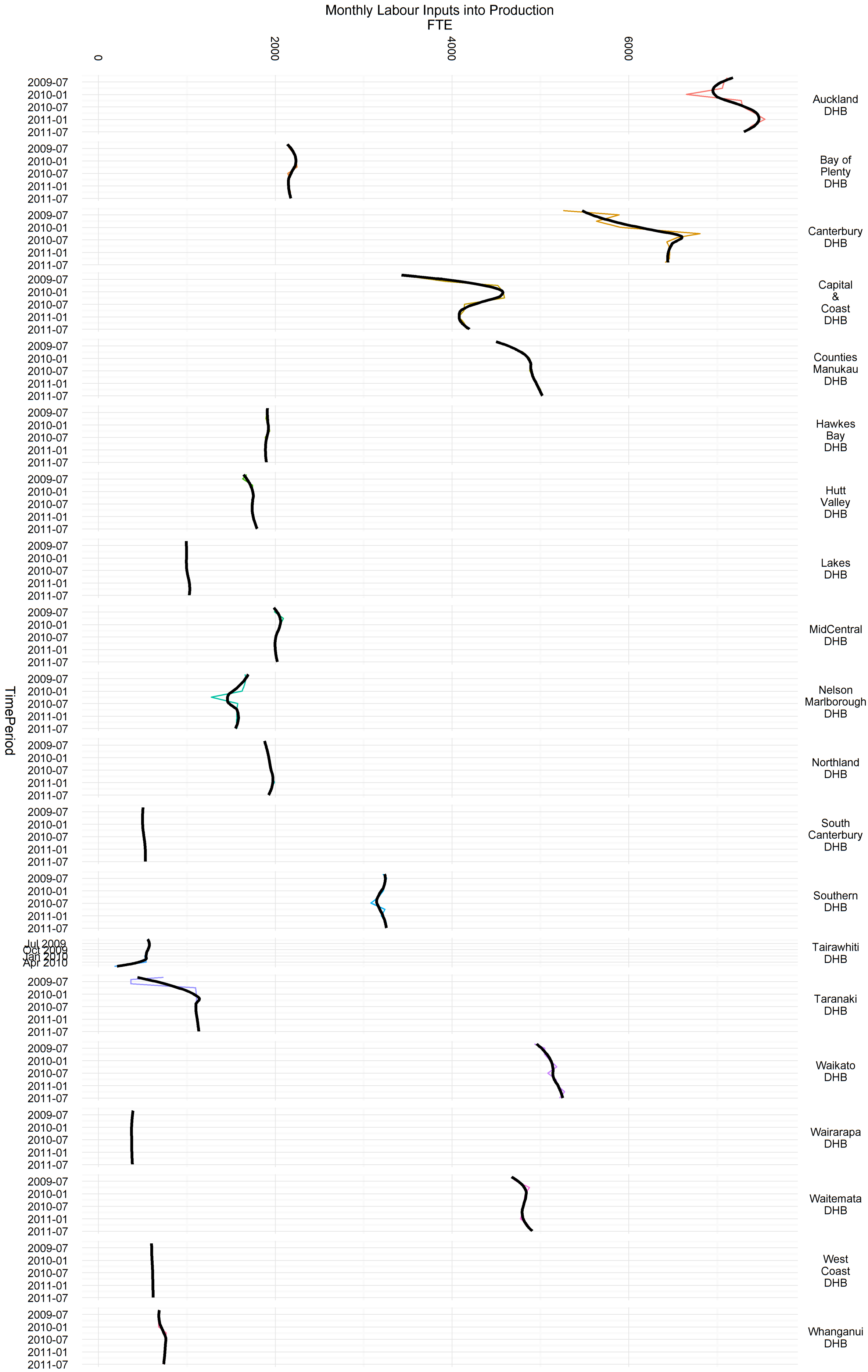
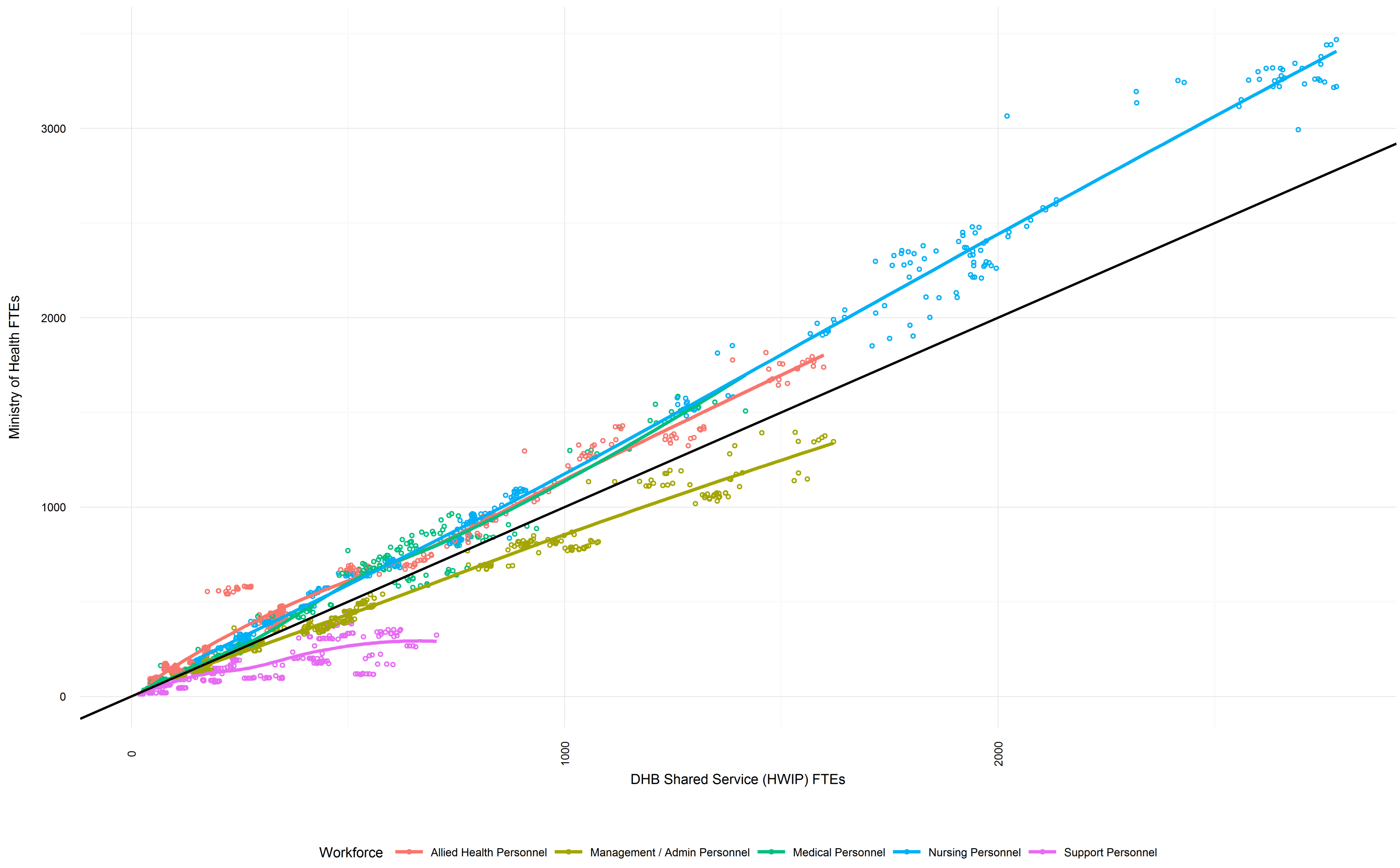


Figure 6: Ratio of Outsourced to Employed Labour Cost, by DHB

Figure 7: HWIP FTE Workforce Size to Ministry of Health FTE Workforce Size



Compared to what DHBs are reporting their workforces to be, MoH data consistently over-estimates the sizes of the nursing, allied health and medical workforce groups, and under-estimates the number of Management and Administration and support workers.

Part of the differences between the MoH and DHBSS workforce measures relates to definitional and measurement differences between the two data sources. The MoH collects an "Accrued" FTE measure.[39] 'Accrued hours' measure staffing hours using accounting notions of cost. DHBs adjust their staffing hour estimates for annual leave / time off / holidays as those leave entitlements accrue, not when they are taken by the employee, meaning full-time employees count as more than one Accrued FTE. Where payroll records do not align with monthly reporting periods, [of Health(2005)] requires DHBs to accrue payroll hours to a monthly, quarterly, or annual reporting period through inflating or deflating actual pay-period hours reported in any reporting period to the actual number of weekday hours in the reporting period. The overall result of the complex calculations for calculating an accrued FTE measure is to reduce the variability of the labour input data supplied by DHBs into the MoH.

The complex process of inflating and deflating pay period hours to coincide with reporting hours, as well as accrue leave when earnt rather than taken has a smoothing effect on the MoH labour measures which was found to *understate* labour's importance in the health-service production process. When both health-service output volumes were compared to the MoH FTE labour measures, the variation within the MoH FTE labour was significantly less than the variation occurring within the delivery of health-services, resulting in the labour measure poorly measuring labour inputs consumed in the health-service production process.

5.3.2 DHB Shared Services - Health Workforce Information Programme (HWIP)

DHBSS estimate and publish alternative labour measures from HWIP. HWIP collects DHB Provider Arm labour market data for workforce forecasting and modelling purposes. Individual employee level record data from DHB human resource information systems is collected by DHBSS. HWIP collects both contracted hours and paid hour labour measures, with more certainty given to the contracted hour measure. The unit record data sources enable HWIP to also estimate workforce headcount labour measures.

HWIP collects workforce information by Australia and New Zealand Standard Occupational

[39] [of Health(2005)]

Classification (ANZSCO), a skill-based classification developed by Statistics New Zealand and the Australian Bureau of Statistics. Being skill-based, a close connection exists between HWIP's measures and the training requirements for different health-sector occupations.

HWIP's data collection was not without its difficulties. In its initial phases, its "Quarterly Reports" - its main publication - was put on hold for a period of time as DHBSS concentrated on improving the data's quality.[40] The effect of data issues can be seen in the size and changes within the "Unknown" workforce group in Figure 8: the difference between individual records which can be allocated to workforce groups, and those that cannot, together with other sources of error.

The high visibility of the workforce estimates published on DHBSS's website[41] together with DHBs being both the source of the data and the "customer" of information have led to the significant data quality improvements over time. For these reasons, HWIP labour information has been used as the quantity measures within equation (12) above.

HWIP data was mapped to financial information derived from section 5.1.1 to estimate average labour costs for each DHB and workforce group over time. Because both the HWIP labour measures and the DHB Financial Monitoring information derive from separate independent data sources, the logic of equation (10) ensures the resulting average labour cost measures are, in effect, a Paasche index of labour "prices" for each workforce group. However, being derived from two separate independent data sources implies that the resulting Paasche labour price measure inherits all of the error occurring within *both* of the two independent data sources.

Figures (11), (13)-(17) at the end of this section describe each DHB's aggregate workforce, and their disaggregate workforce-specific labour costs.

[40]http://www.dhbsharedservices.health.nz/Site/Future_Workforce/HWIP/DHB_Base_Data_Reports.aspx
[41]http://www.dhbsharedservices.health.nz/Site/Future_Workforce/HWIP/DHB_Base_Data_Reports.aspx

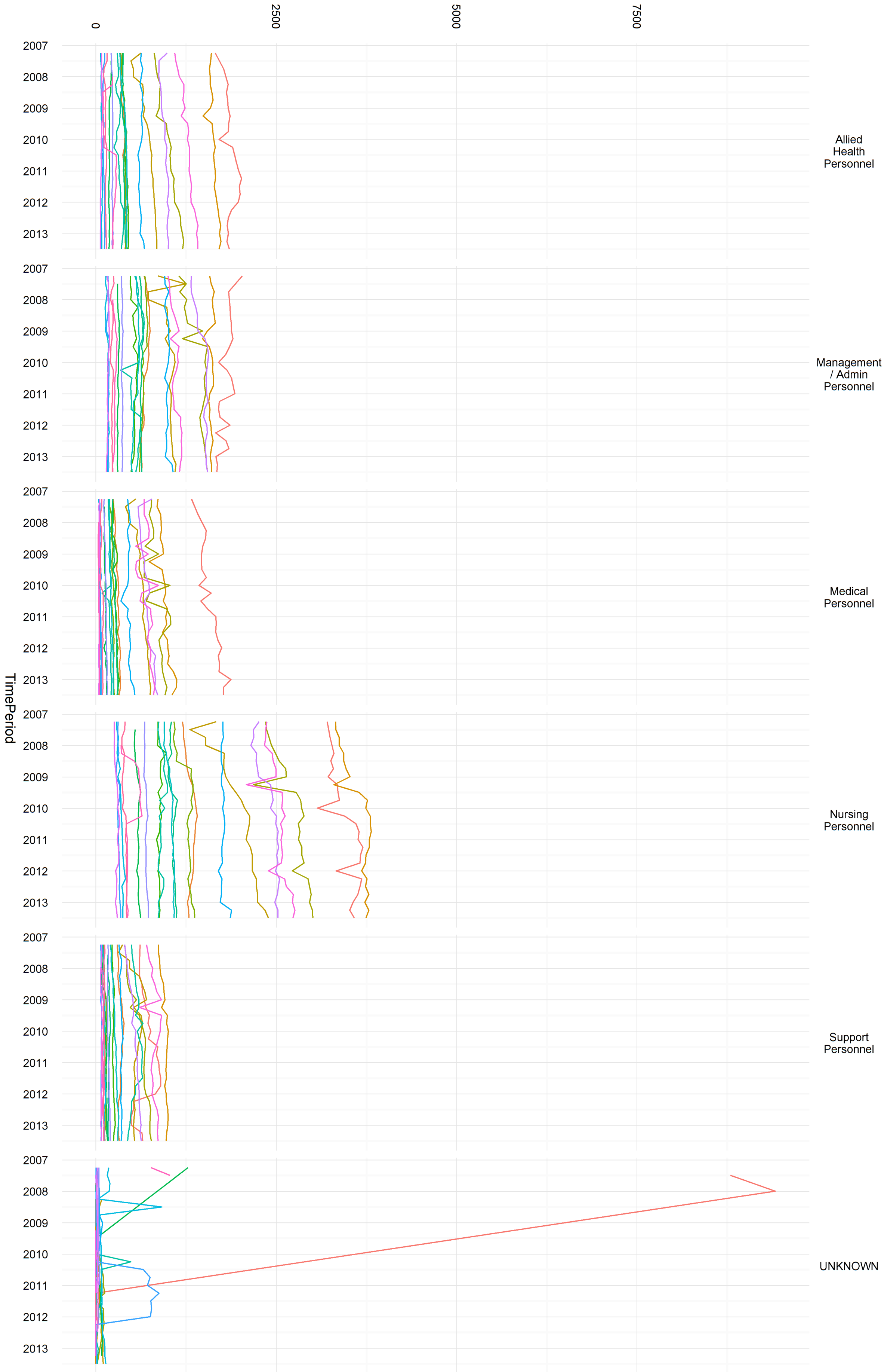


Figure 8: HWIP FTE Workforce Size, by Time and Anonymous DHB

5.4 Capital

The DHB profit and loss statements reflect the value of payments made to employees / suppliers / lenders / owners for inputs used by DHBs in the production of health-services over a period of time. Explicit payments contained within the profit and loss accounts, including the residual surplus value (if any), reflect payments made to the economic factors-of-production for all the inputs used in the production process.

In this thesis, payments to employee factors-of-production are "labour" costs. All other payments, including the size of any surplus after other payments have been made are "capital" costs. "Capital" is further split into three separate mutually-exclusive groups:

- Intermediate Consumption:
  Intermediate consumption are goods and services purchased from other businesses which are entirely consumed in the health-service production process. Within this thesis, outsourced labour for the reasons described in section 5.3, is considered an intermediate consumption service.

- Productive Capital Costs:
  DHB profit and loss statements include depreciation that reflects the loss of economic value through wear-and-tear and diminution of value of assets used in the production process. In theory, "capital services" derived from the productive capital stock ought to be productive capital inputs consumed in the production process, not the "depreciation" component recognised in DHB profit and loss statements. Measuring the value of capital services consumed in the production process that reflect the age-efficiency of the DHB's productive capital stock is difficult. Depreciation is the theoretically closest proxy.

- Financial and Equity Services:
  Financially related interest payments and net profit/ surplus remaining after all other expenses have been paid represent a return to either the lender or owners of financial/equity services provided to the business. "Capital" in a financial sense of lending money to a business either originates from third party lenders, like banks, or through parties taking an equity stake within the business through ownership. Through either channel, interest payments and claims on the residual value of economic production once all other claims have been paid represent the returns to financial/equity services extended to the business.

5.4.1 DHB Capital Inputs

For the year ending June 2013, DHBs collectively spent approximately $7,996 million on the production of health-services through their Provider Arms on the following areas:

- Labour Costs $5,008 million
  - Personnel Costs: $5,008 million
- Capital Costs $2,988 million
  - (Intermediate Consumption) Clinical Supplies: $1,235 million
  - (Intermediate Consumption) Infrastructure and Non-Clinical Supplies: $672 million
  - (Intermediate Consumption) Outsourced Services: $490 million
  - (Productive Capital Costs / Financial and Equity Services) Depreciation, Interest and Return to Government (Capital Charge): $592 million

Labour payments account for approximately 63% of DHB Provider Arm expenditure implying "capital", the Clinical Supplies, Infrastructure, Outsourced services and use-costs described above, account for the remaining 37% of expenditure in the production of health-services.

5.4.2 Estimating DHB Capital Input Quantity

Earlier DHB Monitoring schedules de-composed the Clinical, Infrastructure and Non-Clinical supply costs into the following items:

- Clinical Supplies
  - Treatment Disposables
  - Diagnostic Supplies & Other Clinical Sups.
  - Instruments & Equipment
  - Patient Appliances
  - Implants and Prostheses
  - Pharmaceuticals
  - Other Clinical & Client Costs

- Infrastructure and Non-clinical
  - Hotel Services, Laundry Cleaning
  - Facilities
  - Transport
  - IT Systems & Telecommunications
  - Interest & Financing Charges
  - Professional Fees Expenses
  - Other Operating Expenses
  - Democracy
  - Subsidiaries, Joint Ventures & Minority Interests
  - Infrastructure and Non-clinical supplies

In later periods, the monitoring schedules removed the detail breakdowns of "Clinical Supplies" and "Infrastructure and Non-clinical" costs. Having the earlier period detail allowed the sub-components of the "Clinical Supplies" and "Infrastructure and Non-clinical" costs to be measured and price-deflated. The proportion each sub-component contributed to its high-level cost measure within the base year was used to weight the price deflator for later periods where the sub-components detail was removed from the data.

A composite price deflator for the capital inputs into production was derived from the proportion each sub-component contributed to the value of "Clinical Supplies" and "Infrastructure and Non-clinical" costs in the base year and used to estimate the underlying quantity of capital consumed in production across all the periods included within this thesis.

5.4.3 Price Deflators

A combination of Statistics New Zealand's Capital Goods Price Index (CGPI), its Producer Price Index (PPI) output index and Reserve Bank of New Zealand information was used to estimate the underlying quantity of capital inputs used in the production of health care.

Unless the price deflators are well aligned to the quantity measures within the nominal values being deflated, price deflation is not the preferred method for estimating change in underlying quantity measures. The preferred method for estimating quantity change is through the direct estimation of a quantity index. In the absence of information to direct measure change in capital input quantities, price deflation is a method of last resort; however, the derived quantity measures inherit all the issues associated with the price measure, including any issues with its overall 'fit' to the commodities being deflated.

Table (4) describes the price deflators used in this analysis to derive the underlying quantity of capital inputs used by DHBs in the production of health-services. Statistics New Zealand's price indices are quarterly measures. Monthly estimates of the price indices were derived through linear interpolation for the interceding months of each quarter. The Reserve Bank statistics were already published with a monthly time frequency, allowing their direct application to the monthly DHB data.

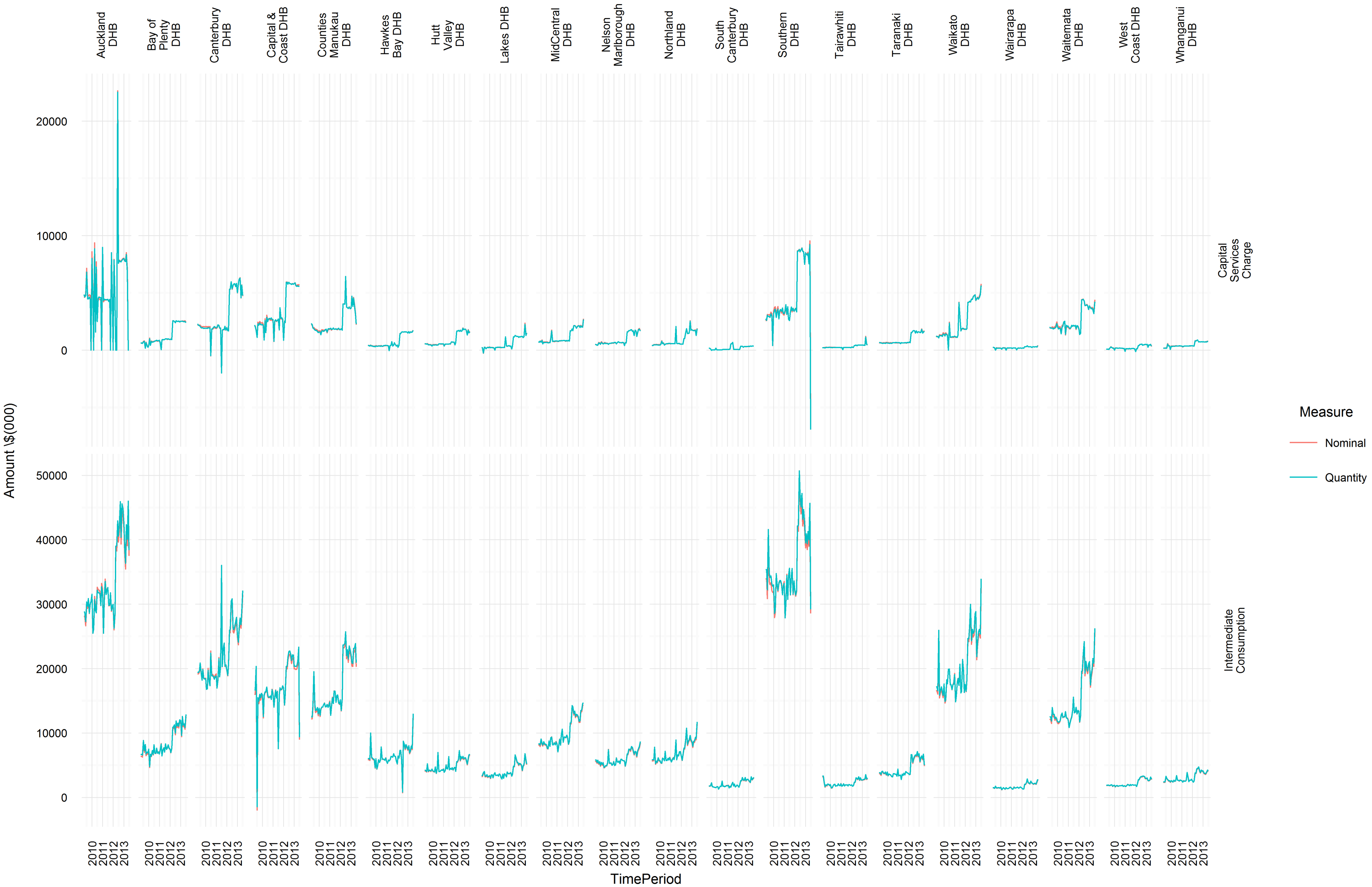
DHB.Cost.Component	SNZ.Price.Index	Specific.Price.Index.Used
FACILITIES	CGPI High Level	All Groups
DEPRECIATION EXPENSE	CGPI High Level	All Groups
INSTRUMENTS & EQUIPMENT	CGPI PME	Medical and surgical equipment and orthopedic appliances
PATIENT APPLIANCES	CGPI PME	Medical and surgical equipment and orthopedic appliances
IMPLANTS AND PROSTHESES	CGPI PME	Medical and surgical equipment and orthopedic appliances
OTHER CLINICAL & CLIENT COSTS	PPI High Level	Professional Scientific Technical Administrative and Support Services
INFRASTRUCTURE & NON-CLINICAL SUPPLIES	PPI High Level	All Industries
DIAGNOSTIC SUPPLIES & OTHER CLINICAL SUPS.	PPI High Level	Manufacturing
OTHER OPERATING EXPENSES	PPI High Level	All Industries
CLINICAL SUPPLIES	PPI Outputs	Basic Chemical and Chemical Product Manufacturing
TREATMENT DISPOSABLES	PPI Outputs	Basic Chemical and Chemical Product Manufacturing
PHARMACEUTICALS	PPI Outputs	Basic Chemical and Chemical Product Manufacturing
HOTEL SERVICES, LAUNDRY & CLEANING	PPI Outputs	Other Store Based Retailing and Non Store Retailing
TRANSPORT	PPI Outputs	Road Transport
IT SYSTEMS & TELECOMMUNICATIONS	PPI Outputs	Telecommunications Internet and Library Services
PROFESSIONAL FEES & EXPENSES	PPI Outputs	Professional Scientific and Technical Services
OUTSOURCED SERVICES	PPI Outputs	Professional Scientific and Technical Services
CAPITAL CHARGE	Reserve Bank	Business Lending Rate (B3 Interest rates on lending and deposits (% pa)
INTEREST COSTS CHFA	Reserve Bank	Business Lending Rate (B3 Interest rates on lending and deposits (% pa)
INTEREST COSTS PRIVATE	Reserve Bank	Business Lending Rate (B3 Interest rates on lending and deposits (% pa)

Table 4: Prices Indicies Use to Deflate Capital Input Costs

Figure (9) graphs both the nominal and constant-price quantity values for intermediate consumption and capital services. The cumulative effect of price deflation has made little difference to the two measures, suggesting that over the relatively short time-horizon for these statistics, price changes have not had a significant effect on DHB capital costs.

Figure (12) at the end of this section presents the aggregate capital inputs for each DHB.

Figure 9: DHB Provider Arm Capital Inputs: Nominal and Quantity Measures



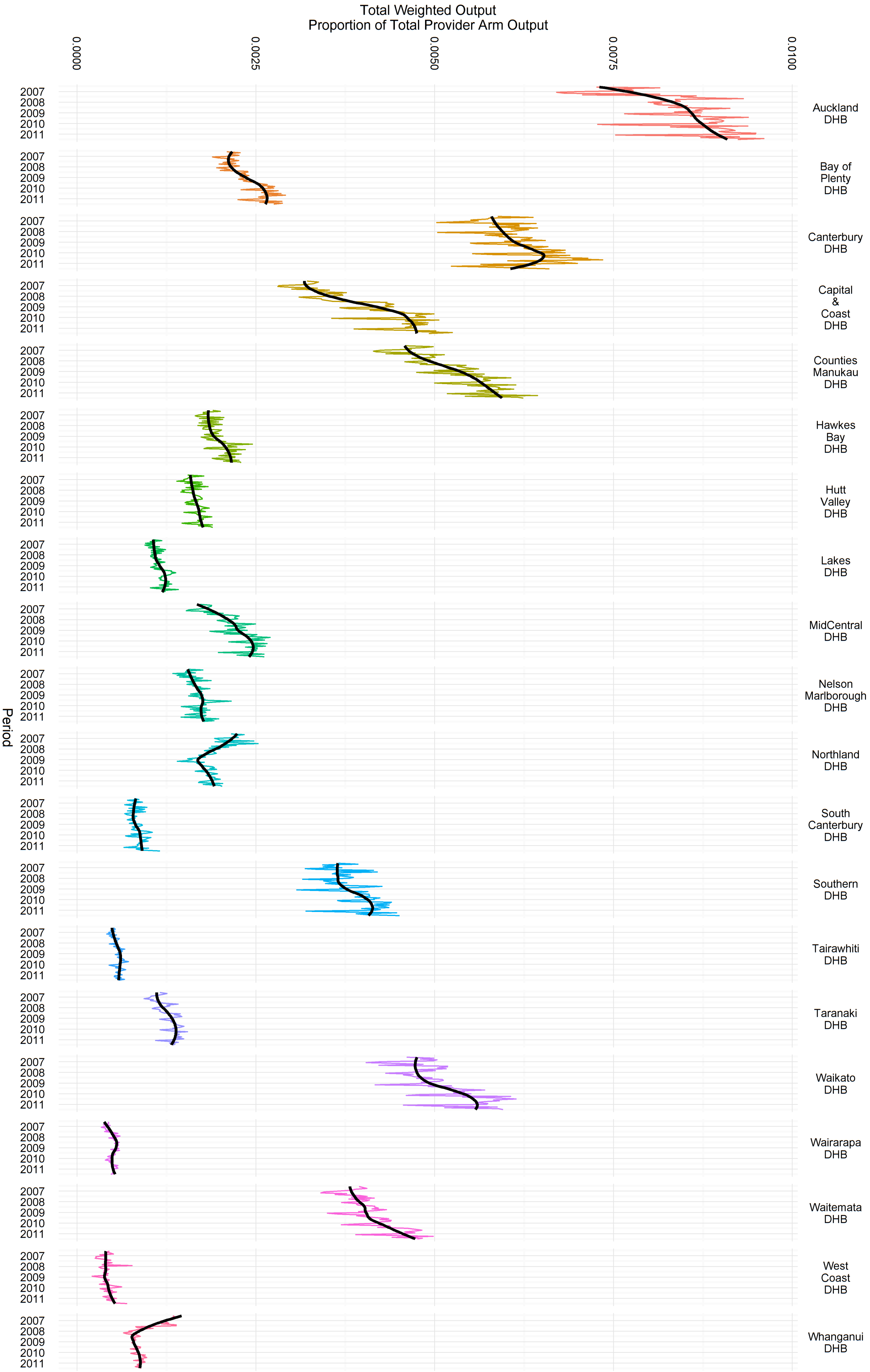
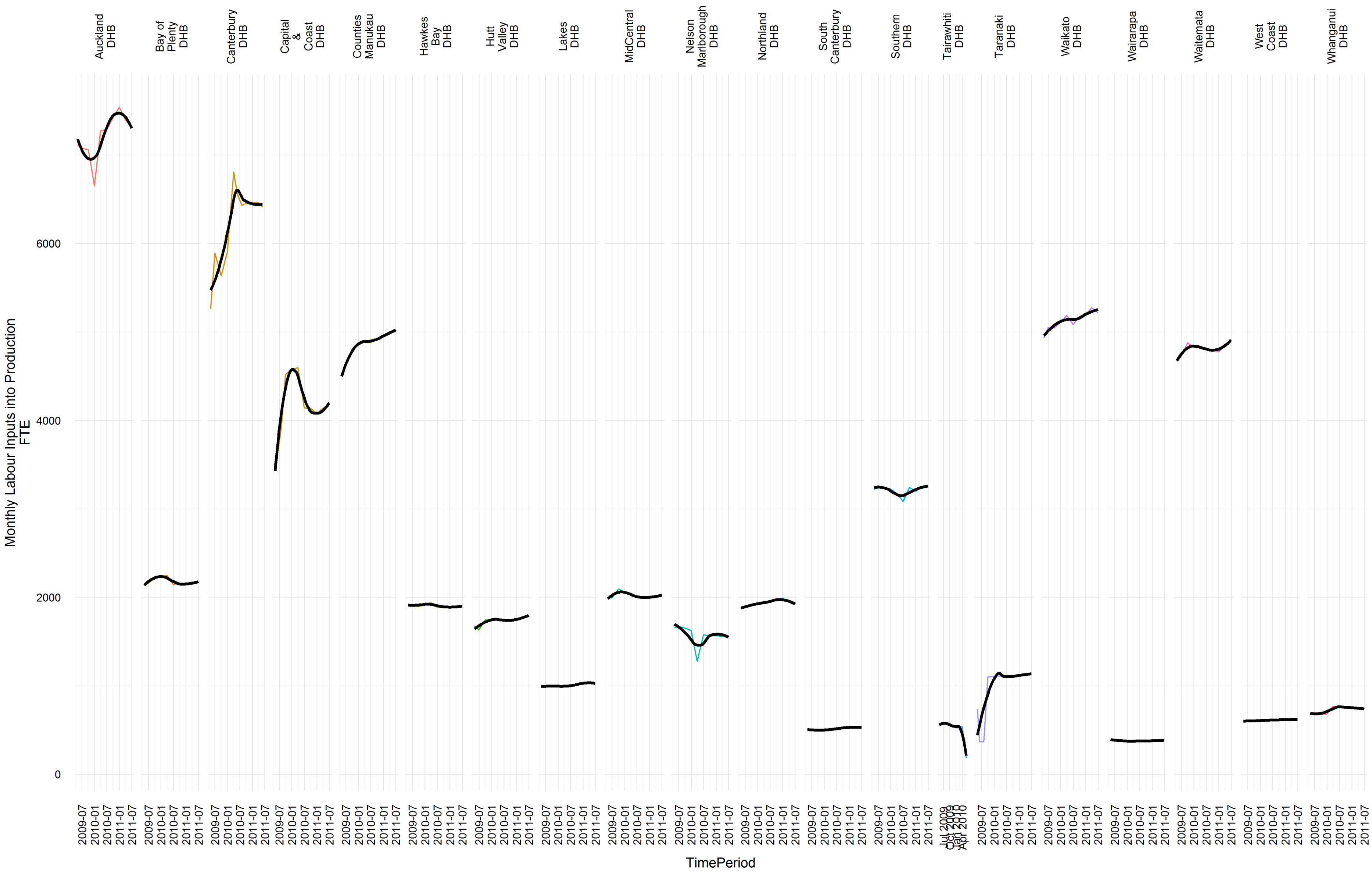


Figure 10: DHB Output Measures

Figure 11: DHB Labour Measures



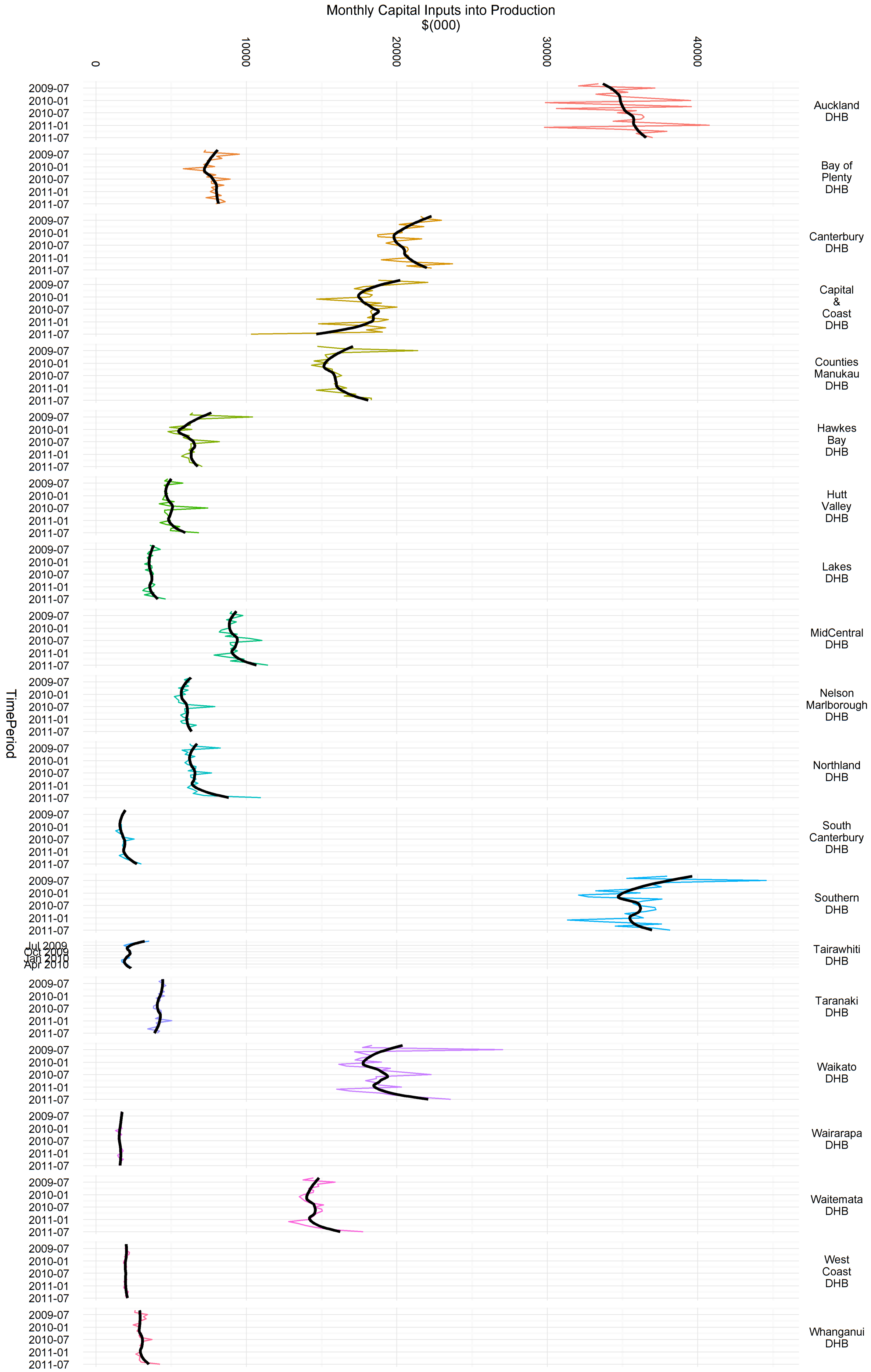
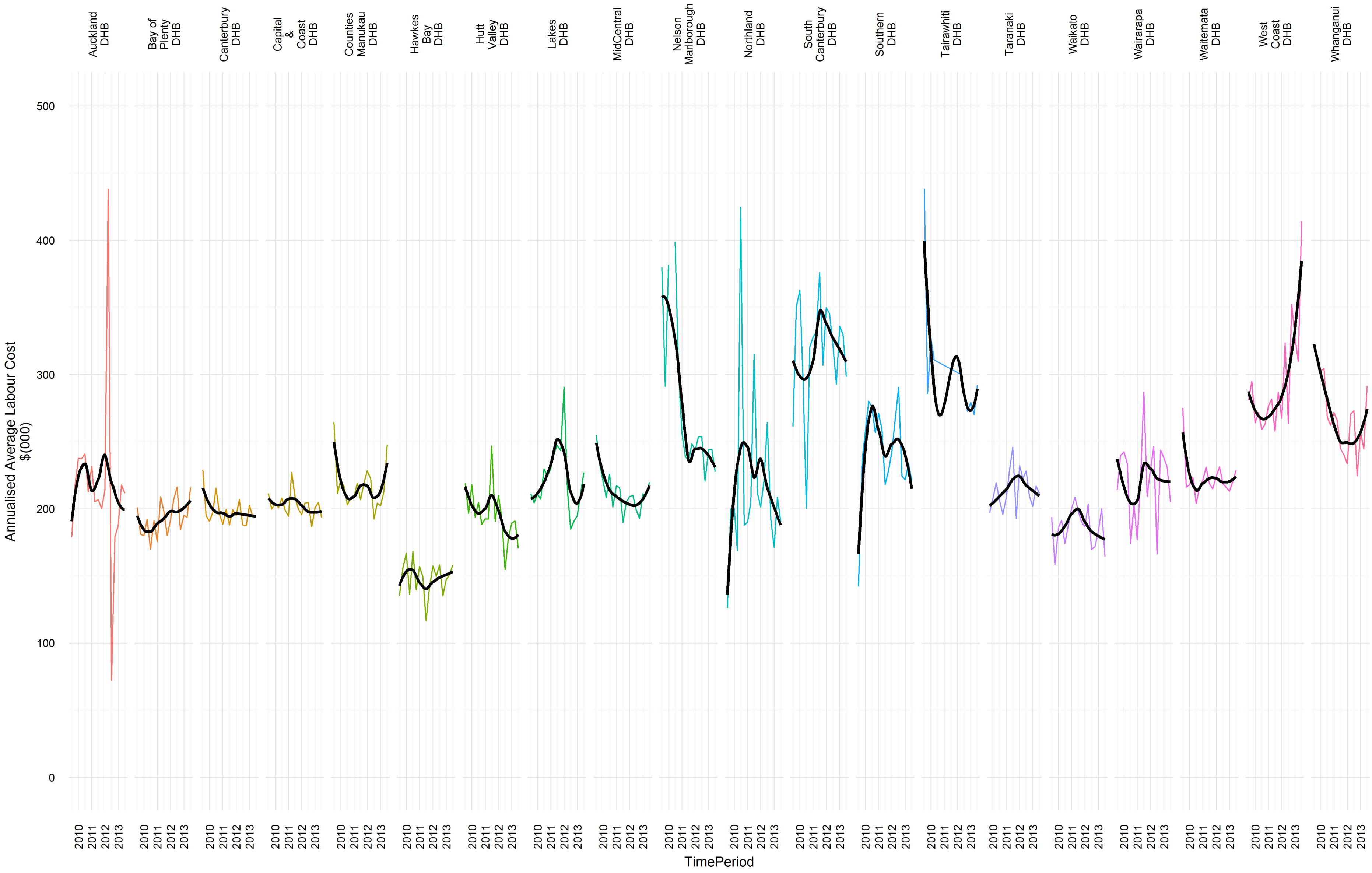


Figure 12: DHB Capital Measures

Figure 13: DHB Labour Prices: Medical Labour Costs



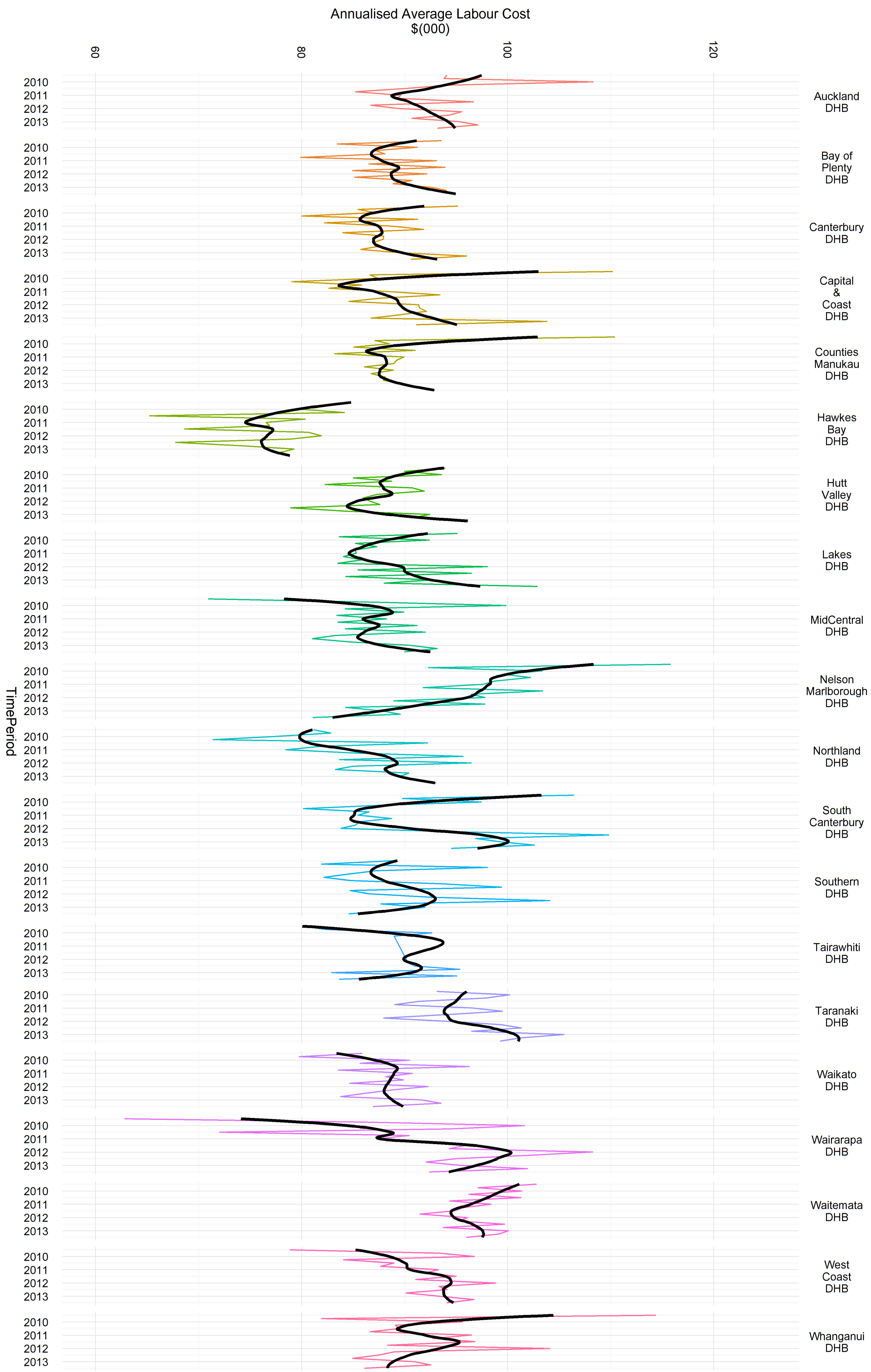
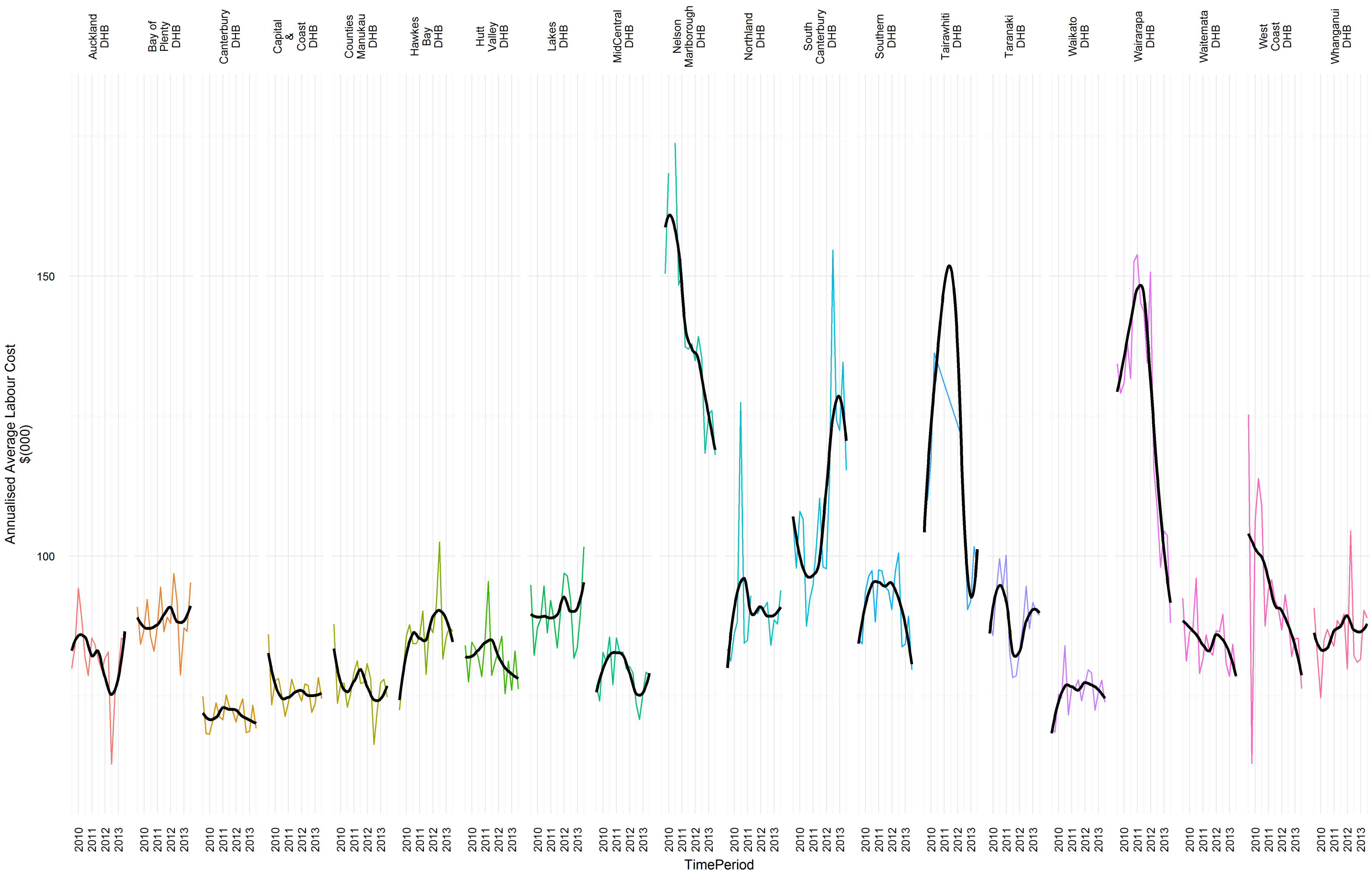


Figure 14: DHB Labour Prices: Nursing Labour Costs

Figure 15: DHB Labour Prices: Allied Health Labour Costs



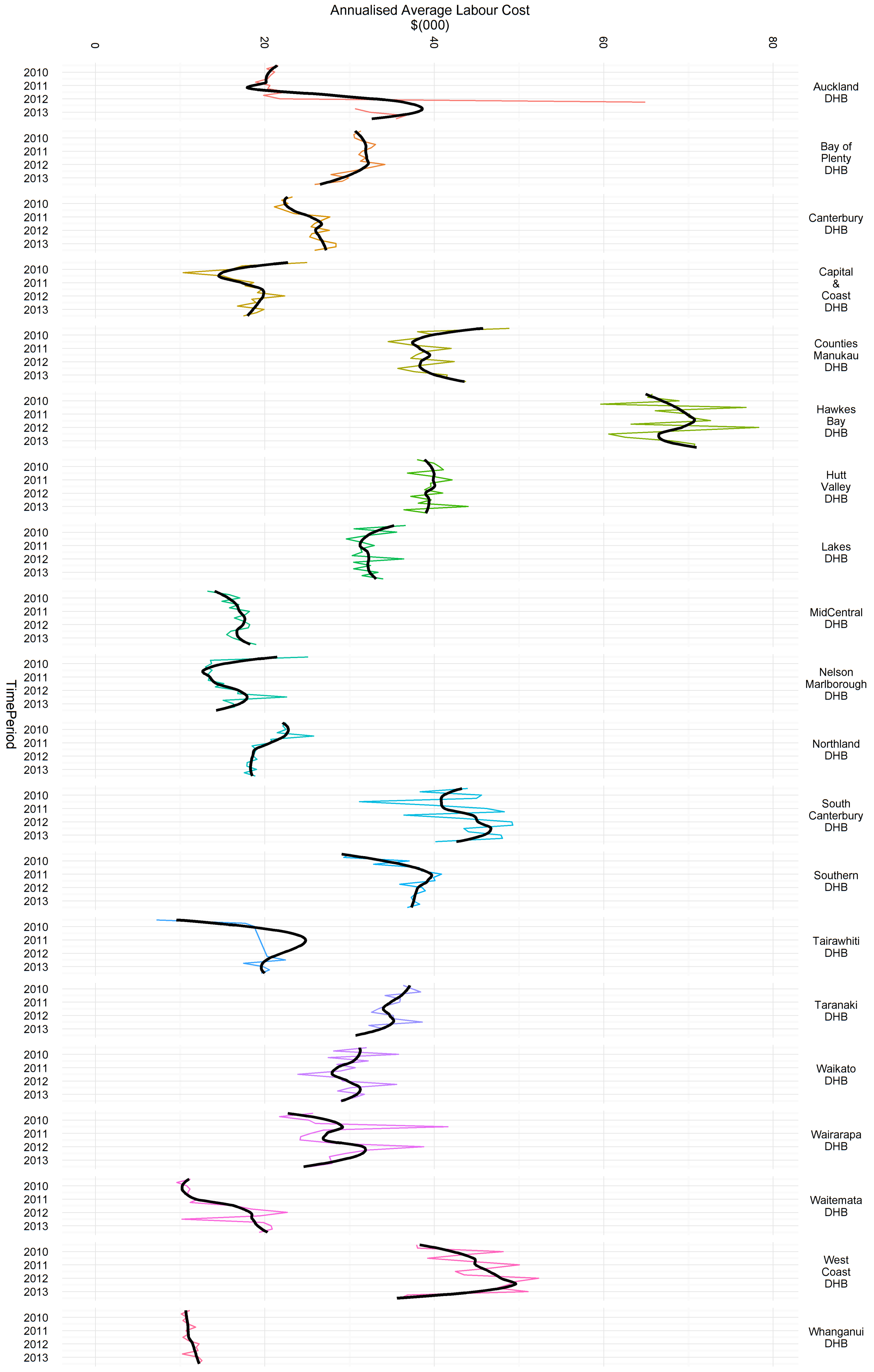
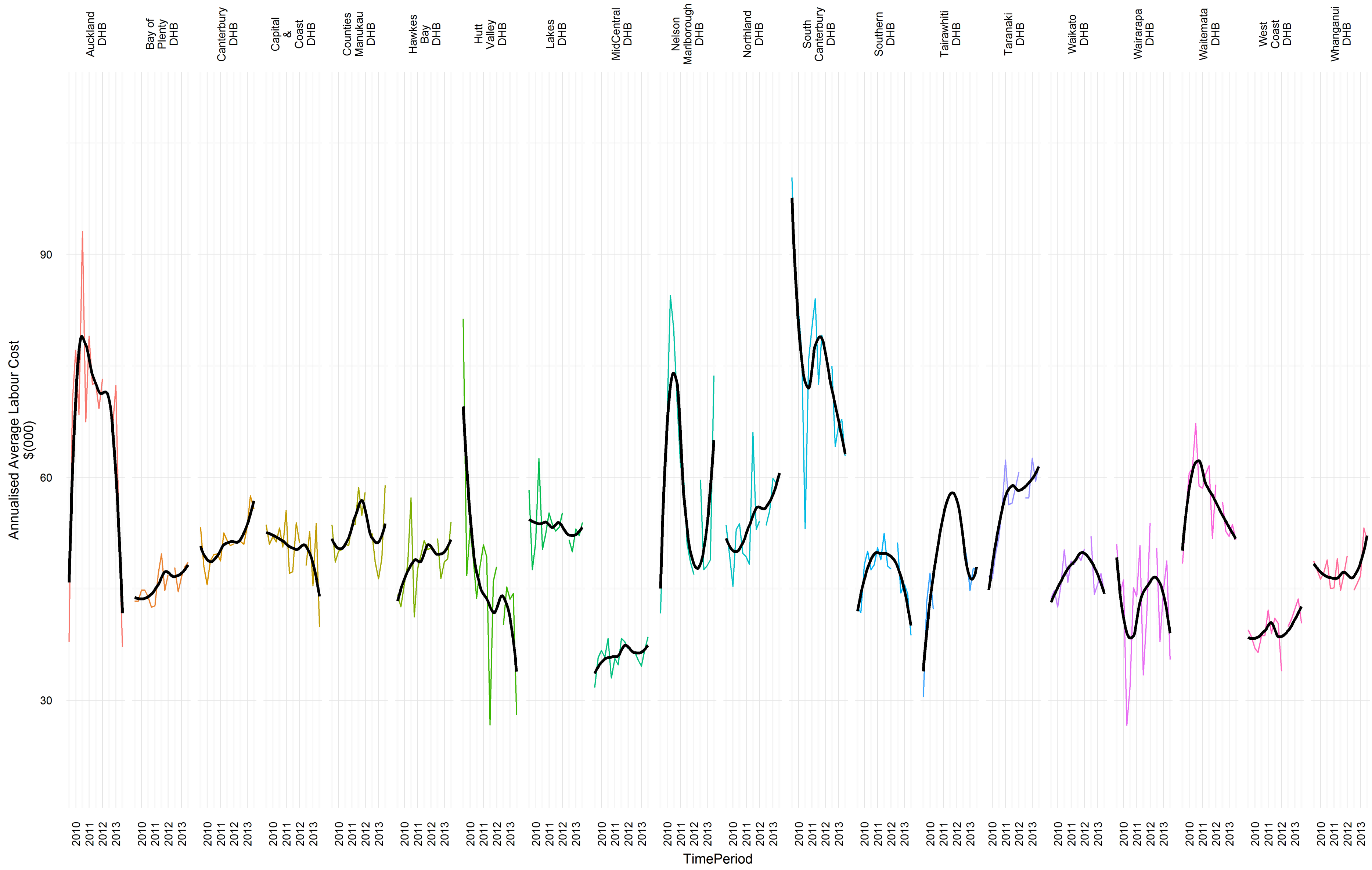


Figure 16: DHB Labour Prices: Support Labour Costs

Figure 17: DHB Labour Prices: Management and Administration Labour Costs



6 Production Economic Theory

Economic production theory starts with a simplified model of production: production is the economic process of transforming goods and service input quantities into goods or service output quantities of another kind. The transformation process is stylistically modelled using a *production function*, typically:[42]

$$Y = F[L, K] \tag{13}$$

where:

Y = a quantity measure of economic output produced within a specific time period,

L = a quantity measure of labour used in the production of Y,

K = a quantity measure of physical capital used in the production of Y.

All of the variables entering equation (13) are *quantity flow measures*: for a given time period, specific quantities of L and K were completely consumed through the transformation described by the production function, into the quantity of output described by variable Y.

The generic production function described in equation (13) is assumed to be continuous and at least twice differentiable, with the marginal products of its inputs positive but decreasing, thus:

$$\frac{\partial Y}{\partial L} = F_L, \frac{\partial^2 Y}{\partial L^2} = F_{LL}, \frac{\partial Y}{\partial K} = F_K, \frac{\partial^2 Y}{\partial K^2} = F_{KK} \tag{14}$$

where: $F_L > 0; F_K > 0; F_{LL} < 0; F_{KK} < 0$

How output changes according to changes in input quantities reflects the production function's *homogeneity*, a property with important economic implications. Adopting [Bairam(1994)]'s terminology:

$$(hL, hK) = F[hL, hK] = h^{\gamma} f(L, K) = h^{\gamma} Y \tag{15}$$

The variable $\gamma > 1$ in equation (15) reflects output increasing more than proportionally to a given change in the inputs to the production process, and production is described as reflecting *increasing returns-to-scale*. Where $\gamma < 1$, output increases less than proportionally in the production process, and production is described as exhibiting *decreasing returns-to-scale*. Where $\gamma = 1$, outputs increase proportionally to a change in the inputs consumed in the production

[42] [Bairam(1994)]

process, and production is described as exhibiting *constant returns-to-scale*, and the production function (15) is *homothetic*.

[Bairam(1994)] outlines four properties associated with the generic production function described in equation (15), which have empirical implications for estimating New Zealand's health-service production process:

- The Elasticity of Scale

  The elasticity of scale, ε, is equivalent to γ and, for homogeneous production functions, is constant for all levels of production activity. Importantly, ε is the sum of the partial output elasticities with respect to each input, or:

  $$\varepsilon = \sum \varepsilon_i = \sum \left[\frac{\partial Y}{\partial X_i} / \frac{X_i}{Y} \right] \tag{16}$$

  The $\frac{\partial Y}{\partial X_i}$ component of (16) is the marginal product of input X_i, while $\frac{X_i}{Y}$ is the inverse of the average product with respect to input X_i. For a production function to exhibit decreasing returns-to-scale, *all* marginal input products need to be less than their average product: the increase in production of the next i^{th} unit of input must be less than the average increase from all preceding inputs consumed in the production process.

- Economic Returns to the Factors-of-Production

  A homothetic production function, with inputs purchased from competitive markets implies:

  $$\frac{\partial Y}{\partial L} L + \frac{\partial Y}{\partial K} K = \gamma Y \tag{17}$$

  From equation (17), the entire value of the output, γY, is allocated back to the production inputs according to their production-determined marginal productivities, $\frac{\partial Y}{\partial L}$ and $\frac{\partial Y}{\partial K}$. The first order conditions of cost-minimisation require $\frac{\partial Y}{\partial L} = W$ and $\frac{\partial Y}{\partial K} = r$, where W and r are "the" labour price, and "the" capital price rates.

  From a homothetic function, the entire value of output is returned to the factors-of-production in proportion to the input marginal productivities from the production function, and their existing input quantities. The situation changes when either increasing or decreasing returns-to-scale are the prevailing production conditions. Under increasing returns-to-scale, the left hand side of equation (17) is greater than the value on the right and "excess" returns result.

- The Marginal Rate of Technical Substitution

  In the simplified two input model of production defined in equation (13), the marginal rate of technical substitution (MRTS) between the inputs is:

$$\begin{aligned} \Delta Y = & \tfrac{\partial Y}{\partial L} dL + \tfrac{\partial Y}{\partial K} dK = 0 \\ \tfrac{dL}{dK} = & -\tfrac{\partial Y / \partial K}{\partial Y / \partial L} \end{aligned} \tag{18}$$

  which reflects how one input to the production process needs to change when another input is changed to ensure output remains at the same level.

  When the number of inputs consumed in the production process expands beyond two, the MRTS becomes more difficult to interpret:

$$\begin{aligned} \Delta Y = & \tfrac{\partial Y}{\partial L} dL + \tfrac{\partial Y}{\partial K} dK + \tfrac{\partial Y}{\partial X} dX = 0 \\ \tfrac{dK}{dL} = & -\tfrac{\partial Y / \partial L}{\partial Y / \partial K} - \left[\tfrac{\partial Y / \partial X}{\partial Y / \partial K} \right] \tfrac{dX}{dL} \end{aligned} \tag{19}$$

  Equation (19) describes the MRTS of two of three inputs, K and X, consumed in an arbitrary production process to a change in the third input, L. Without the effect of the third variable, X, the MRTS is equivalent to equation (18).

  The effect of the third variable creates another "channel" through which the input adjustment process may operate. Depending on the relative magnitudes of the marginal products of the inputs within equation (19):

$$\frac{dK}{dL} = 0 \text{ if } \frac{\partial Y / \partial L}{\partial Y / \partial K} = - \left[\frac{\partial Y / \partial X}{\partial Y / \partial K} \right] \frac{dX}{dL} \tag{20}$$

  Only if the inputs are strongly separable such that $\frac{dX}{dL} = 0$ does equation (19) reduce to equation (18). If the more likely assumption of $\frac{dX}{dL} \neq 0$ holds, then how much each input needs to changes in order to maintain output when one input is reduced is a complex interaction between input marginal productivities and changes in other inputs which are induced by the initial change itself.

  If inputs X and L are complement inputs in the production process, then $\frac{dX}{dL} > 0$ and the capital adjustments in equation (19) needed to maintain output are consequently larger. Alternatively, if inputs X and L are substitutes, then $\frac{dX}{dL} < 0$ and induced changes in X will offset the change in capital needed to maintain output.

In a health production sense, inputs to the production process may be labour, capital, and outsourced services. In the event of a labour strike, which reduces L available for use in the production process, the ability of a DHB to maintain its health-service throughput may depend on whether outsourced services are complements or substitutes for labour. If outsourced services consist of locum doctors - a labour substitute - then the economic impact of a labour strike may be partially offset by increasing locum-provided care. If outsourced services is a contracted laboratory capability closely engaging with the workforce currently on strike, and an input complement to labour, then a loss of labour induces a loss in diagnostic services, exacerbating the adjustment process of capital needed to maintain health-service throughput volumes.

- The Elasticity of Substitution

  Closely tied to the concept of the MRTS, the elasticity of substitution (σ) measures the relative "ease" that one input to the production process may be substituted for another. Definitionally, in the simplified two input case:

$$\sigma = \frac{dlog(K/L)}{dlog(\text{MRTS})} \tag{21}$$

  [Bairam(1994)] identifies σ as one of the most powerful indexes of the properties of the production function since, under certain circumstances σ uniquely determines the production function's form.[43] The main difference between the MRTS and σ is that σ reflects the ability to substitute inputs for each other at a specific level of input scale, reflected by dlog(K/L). However, as the number of inputs expands beyond two, σ inherits the complexity of interaction which affects the calculation of the MRTS.

6.1 Modelling DHB Provider Arm Health Service Production

6.1.1 Cobb-Douglas Production (CD)

Cobb-Douglas (CD) is the simplest functional model of an economic production process, and has the form:

[43] [Bairam(1994)] at page 11.

$$Y = \gamma \left(K^{\alpha} L^{\beta} \right) \tag{22}$$

where:

Y = a quantity measure of economic output produced within a specific time period,

L = a quantity measure of labour used in the production of Y,

K = a quantity measure of physical capital used in the production of Y,

α = the relative capital factor intensity,

β = the relative labour factor intensity,

γ = Hicksian-neutral technological growth,

The elasticity of scale, ε, is well-defined as:

$$\varepsilon = \alpha + \beta \tag{23}$$

CD is a popular applied production function since the logarithmic transformation of equation (22) generates an easily estimatable linear function of the inputs into the production process:

$$log(Y) = log(\gamma) + \alpha log(K) + \beta log(L) \tag{24}$$

CD technology is extensible to include multiple inputs into the production process, making it a popular first-estimated production technology for most applied work; however, when extended to include multiple inputs, CD's well know limitation is that it specifies a unitary elasticity of substitution across all inputs which implies all inputs can easily be replaced with each other:

$$\sigma = \frac{\text{dln }(K/L)}{\text{dln(MRS)}} = 1 \tag{25}$$

6.1.2 Constant Elasticity of Substitution Production (CES)

In a two productive input model of economic production, with the assumption of homothetic technology, the basic constant elasticity production (CES) function is denoted by:

$$Y = A\big[\delta L^{-\rho} + (1-\delta)K^{-\rho}\big]^{-\gamma/\rho} \tag{26}$$

where:

Y = a quantity measure of economic output produced within a specific time period,

L = a quantity measure of labour used in the production of Y,

K = a quantity measure of physical capital used in the production of Y,

δ = the relative labour factor intensity used in the production,

A = Hicksian-neutral technological growth,

γ = returns-to-scale factor. Under the assumption of homothetcity, γ is equal to 1.

To derive the marginal products of the inputs into the production process, let:

$$\psi = \left[\delta L^{-\rho} + (1-\delta)K^{-\rho}\right] \tag{27}$$

Combining equation (27) with equation (26) simplifies equation (26) to become:

$$Y = A\psi^{-1/\rho} \tag{28}$$

Deriving the elasticity of substitution (σ) proceeds from equation (28) through taking the marginal products of the production function. Focusing initially on labour then, through the Chain Rule:

$$\frac{\partial Y}{\partial L} = \frac{-A}{\rho}\left(\psi^{-\left(\frac{1}{\rho}\right)-1}\right)\frac{\partial \psi(L)}{\partial L} \tag{29}$$

where,

$$\frac{\partial \psi(L)}{\partial L} = -\delta\rho L^{-\rho-1} \tag{30}$$

making equation (29) become:

$$\frac{\partial Y}{\partial L} = \frac{-A}{\rho}\left(\psi^{-\left(\frac{1}{\rho}\right)-1}\right)\left(-\delta\rho L^{-\rho-1}\right) \tag{31}$$

Removing variables which cancel out, equation (31) further reduces to:

$$\frac{\partial Y}{\partial L} = A\delta\left(\psi^{-\left(\frac{1+\rho}{\rho}\right)}\right)L^{-(1+\rho)} \tag{32}$$

Substituting equation (27) back into equation (32) produces for the partial derivative of labour:

$$\frac{\partial Y}{\partial L} = A\delta\left(\left[\delta L^{-\rho} + (1-\delta) K^{-\rho}\right]\right)^{-\left(\frac{1+\rho}{\rho}\right)} L^{-(1+\rho)} \tag{33}$$

Through symmetry of the production function in its inputs in equation (26), the marginal product of capital is likewise defined as:

$$\frac{\partial Y}{\partial K} = A(1-\delta)\left(\left[\delta L^{-\rho} + (1-\delta) K^{-\rho}\right]\right)^{-\left(\frac{1+\rho}{\rho}\right)} K^{-(1+\rho)} \tag{34}$$

The marginal rate of substitution (MRS) between capital and labour - a measure of the concavity of the production function at a given level of output - is defined as:

$$\text{MRS} = \frac{\partial Y/\partial L}{\partial Y/\partial K} \tag{35}$$

Substituting equation (33) and equation (34) into equation (35) produces:

$$\text{MRS} = \frac{A\delta\left(\left[\delta L^{-\rho} + (1-\delta) K^{-\rho}\right]\right)^{-\left(\frac{1+\rho}{\rho}\right)} L^{-(1+\rho)}}{A(1-\delta)\left(\left[\delta L^{-\rho} + (1-\delta) K^{-\rho}\right]\right)^{-\left(\frac{1+\rho}{\rho}\right)} K^{-(1+\rho)}} \tag{36}$$

Which, simplifies into:

$$\text{MRS} = \frac{\delta L^{-(1+\rho)}}{(1-\delta) K^{-(1+\rho)}} \tag{37}$$

and

$$\text{MRS} = \frac{\delta}{(1-\delta)}\left(\frac{L}{K}\right)^{-(1+\rho)} \tag{38}$$

finally:

$$\text{MRS} = \frac{\delta}{(1-\delta)}\left(\frac{K}{L}\right)^{(1+\rho)} \tag{39}$$

The Elasticity of Substitution, σ, is a measure of the relative "ease" with which one input can be substituted for another for a given ratio of capital and labour inputs employed in the production process.

In theory, σ is a *relative* substitution measure: its magnitude is dependent on the existing relative size of the inputs actually currently used in the production process, together with the MRS reflecting the production function's concavity with respect to the existing level of economic production. The "constant"ness of the elasticity of substitution for the CES production function is a restriction imposed on the CES functional form which makes σ independent of the current factor input ratios. Consequently, as the ratio of capital to labour changes, the value of σ is constant throughout.

σ is defined as:

$$\sigma = \frac{\text{dln}\,(K/L)}{\text{dln(MRS)}} \tag{40}$$

From equation (39), taking the natural logs of both sides of equation (39) gives:

$$\ln(\text{MRS}) = \ln\left(\frac{\delta}{(1-\delta)}\right) + (1+\rho)\ln\left(\frac{K}{L}\right) \tag{41}$$

which, when differentiating ln(MRS) with respect to (K/L), gives:

$$\frac{\text{dln(MRS)}}{\text{dln}\ (K/L)} = 1+\rho \tag{42}$$

or

$$\sigma = \frac{\text{dln}\ (K/L)}{\text{dln(MRS)}} = \frac{1}{1+\rho} \tag{43}$$

Using the results from equation (43) and equation (26), equation 1 in [Klump et al.(2012)Klump, McAdam, ar can be derived.

From $\sigma = \frac{1}{1+\rho}$, then

$$1+\rho = \frac{1}{\sigma} \Rightarrow \rho = \frac{1}{\sigma} - 1 = \frac{1}{\sigma} - \frac{\sigma}{\sigma} = \frac{1-\sigma}{\sigma} \tag{44}$$

and

$$-\rho = -\left[\frac{1-\sigma}{\sigma}\right] = \frac{\sigma-1}{\sigma} \tag{45}$$

Replacing $-\rho$ in equation (26) with equation (45) and setting $\gamma = 1$ gives:

$$Y = A\Big[\delta L^{\frac{\sigma-1}{\sigma}} + (1-\delta)K^{\frac{\sigma-1}{\sigma}}\Big]^{\frac{\sigma}{\sigma-1}} \tag{46}$$

replicating [Klump et al.(2012)Klump, McAdam, and Willman] equation 1.

6.1.3 Box-Cox Production Function (BC)

[Bairam(1994)] describes a modification of the Cobb-Douglas / CES production function that employs a Box-Cox transformation on its input and output variables.

$$\frac{Y^{\lambda}-1}{\lambda} = A(t) + \alpha\left(\frac{L^{\lambda}-1}{\lambda}\right) + \beta\left(\frac{K^{\lambda}-1}{\lambda}\right) \tag{47}$$

Bairam's Box-Cox transformation has the advantage of encapsulating both Cobb-Douglas and CES technology within its parameters when $\lambda = 0$ or $\lambda < 1$ respectively. When $\lambda = 1$, equation (62) is a linear function of the inputs into production.

The marginal input productivities for equation (62) are given by:

$$f_L = \alpha(\frac{L}{Q})^{\lambda-1} \tag{48}$$

and

$$f_K = \beta(\frac{K}{Q})^{\lambda-1} \tag{49}$$

[Hsing(1996)], expanding on the properties of equation (62), also noted the output elasticities with respect to the inputs are:

$$E_{QL} = \alpha(\frac{L}{Q})^{\lambda} \tag{50}$$

and

$$E_{QK} = \beta(\frac{K}{Q})^{\lambda} \tag{51}$$

The non-homogeneous elasticity of scale for equation (62) is:

$$\varepsilon = \alpha(\frac{L}{Q})^{\lambda-1} + \beta(\frac{K}{Q})^{\lambda-1} \tag{52}$$

Finally, the elasticity of substitution, σ, is:

$$\sigma = 1/(1-\lambda) \tag{53}$$

[Bairam(1994)] Box-Cox (BC) production function has not been without its critics. [Grimes(1991)] argues the BC production function fails to satisfy non-classical production function properties since under general conditions, equation (62) implies output can be generated without capital or labour inputs used in the production process.

Respecifying the BC production function, [Grimes(1991)] shows equation (62) is equivalent to:

$$Y = \gamma \left\{ \mu + \delta L^{\lambda} + (1-\delta) K^{\lambda} \right\}^{\frac{1}{\lambda}} \tag{54}$$

$$\text{where} \quad \gamma = (\alpha + \beta)^{\frac{1}{\lambda}} \tag{55}$$

$$\delta = \frac{\alpha}{(\alpha + \beta)} \tag{56}$$

$$\mu = \frac{(A\lambda + 1 - \alpha - \beta)}{(\alpha + \beta)} \tag{57}$$

If $\mu \neq 0$, then at the point $K = L = 0$ equation (54) reduces to:

$$Y = \gamma \left\{ A\lambda + 1 \right\}^{\frac{1}{\lambda}} \neq 0 \tag{58}$$

implying non-zero (even negative) output results from the effects of Hicksian-neutral technological growth only.

Despite [Grimes(1991)] zero-input special criticism, the BC production function has received attention within the applied literature with favourable results. [Hsing(1996)], exploring regional manufacturing production functions for the different states within the United States of America, found the BC production function performed best between choices of the CD, CES, a translog production function, a generalised Leontief function and equation (62). Equation (62) produced the best applied results, with a plausible elasticity of substitution and total output elasticities.

[Hsing(1996)] found the output elasticities of capital and labour across different states, with decreasing / constant / increasing returns-to-scale for manufacturing production occurring in different states. The states with increasing returns-to-scale also had the highest level of capital deepening; however, with only a low correlation between capital/labour ratios and returns-to-scale, other factors were affecting the efficiency of manufacturing in some states. The same author, in an earlier work,[44] found similar superior performance of equation (62) when exploring state-level aggregated industry manufacturing production.

[44] [Hsing(1993)]

6.2 Estimating Production in a System-of-Equations

Recent empirical production analysis, reflecting both advances in statistical computing and non-linear optimisation techniques, has focused on estimating empirical production functions within a system-of-equation context.

[Klump et al.(2012)Klump, McAdam, and Willman], focusing on the concept of "normalising" a CES production function when estimating it from time-series data, described the specification of an estimatable system-of-equations, defined by the production function and the first order conditions of profit maximisation. Equations 34 - 36 in [Klump et al.(2012)Klump, McAdam, and Willman]'s paper[45] specified the system-of-equations in normalised form that, when applied to this thesis, looks like:

$$\begin{array}{lrl}
\text{Health Sector Production:} & Y_{ti} = & A\left[\delta L_{ti}^{-\rho} + (1-\delta) K_{ti}^{-\rho}\right]^{-1/\rho} \\
\text{Labour Market Clearing:} & \frac{\partial Y}{\partial L} = w_{ti} = & A\delta\left(\left[\delta L_{ti}^{-\rho} + (1-\delta)\, K_{ti}^{-\rho}\right]\right)^{-\left(\frac{1+\rho}{\rho}\right)} L_{ti}^{-(1+\rho)} \\
\text{Capital Market Clearing:} & \frac{\partial Y}{\partial K} = r_{ti} = & A\,(1-\delta)\left(\left[\delta L_{ti}^{-\rho} + (1-\delta)\, K_{ti}^{-\rho}\right]\right)^{-\left(\frac{1+\rho}{\rho}\right)} K_{ti}^{-(1+\rho)}
\end{array} \tag{59}$$

where i = individual DHB.

The equations within the system-of-equations in (59) are non-linear: ρ enters the modelling as a power function of the inputs individually and in a transformed power function of the production and the first order conditions associated with the input factor markets. Estimating equation (59)'s system-of-equations, where a two input CES production function is simultaneously estimated with production's marginal input factor productivities as the input demand functions for input factor markets, is the main focus of this thesis.

While advances in computer-based optimisation processes have allowed once un-estimable non-linear functions to be empirically estimated, the non-linear nature of the optimisation processes makes estimating the system-of-equations (59) *extremely* sensitive to the initiating values needed for the optimisation processes. If optimisation does occur, the results are not yet always reliable due to convergence difficulties.[46]

[45] [Klump et al.(2012)Klump, McAdam, and Willman] on page 788
[46] [_SysFit?]

6.2.1 A Cobb-Douglas System-of-Equations

In case the CES system-of-equations fails to converge to a solution, a linearised Cobb-Douglas variant of equations (59) will also be estimated. A linearised system will ensure an estimatable solution results.

$$
\begin{array}{lrl}
\text{Health Sector Production:} & log(Y_{ti}) = & log(A_{ti}) + \alpha log(L_{ti}) + \beta log(K_{ti}) \\
\text{Labour Market:} & \frac{\partial Y}{\partial L} = log(w_{ti}) = & log(A_{ti}\alpha) + (\alpha - 1)log(L_{ti}) + \beta log(K_{ti}) \\
\text{Capital Market:} & \frac{\partial Y}{\partial K} = log(r_{ti}) = & log(A_{ti}\beta) + (\alpha)log(L_{ti}) + (\beta - 1)log(K_{ti})
\end{array}
\tag{60}
$$

The data sources within this thesis include a rich specification of labour inputs used in the production process. Equation (60) system-of-equations, in Cobb-Douglas form, allows for the extension of the input variables beyond two input factors-of-production.

The "cost" of the increased flexibility of adopting an expanded Cobb-Douglas production functional form is Cobb-Douglas well-known unity elasticity of substitution: all input factors are equally substitutable for each other in the production process. Also, since the underlying "true" production process is unknown, estimated results may suffer from misspecification bias. There's benefits and costs either way, which makes empirical analysis the final determinant of the merits of an expanded Cobb-Douglas functional approach.

6.2.2 Interpreting the System-of-Equations

Within the labour market system-of-equations in either (59) or (60), DHB demand for labour is determined by labour's marginal productivity derived from the DHB Provider Arm production function. Similarly, DHB capital demands reflect DHB marginal rates of capital productivity.

DHBs employ labour, expanding the labour input in both the production function and its marginal rate of labour productivity, until the marginal revenue product (the value contributed to total production by the last employed worker) is equal to the price of the last employed worker purchased from the labour market. Similarly for capital: firms invest in and expand the volume of capital employed in production, up until the value of the contribution of the last quantity of capital to production equals capital's market price.

The labour market and capital market equations in the system-of-equations define a relationship that exists between the market price of an input used in production, and the value it individually adds to output. In the labour market equation, so long as $\frac{\partial log(W_{ti})}{\partial log(K_{ti})} > 0$ and $\alpha < 1$, then $\frac{\partial log(W_{ti})}{\partial log(L_{ti})} < 0$ and DHB marginal revenue product is declining with increasing quantities of labour employed in production, but increasing if more capital is used in the production process.

As more labour becomes employed, the declining marginal productivity suggests the labour-market determined labour costs should fall. As DHBs increase the volume of capital employed in production, the demand for labour increases due to higher scales of production increasing the marginal productivity of labour feeding through into the labour market and leading to higher wages.

6.2.3 MECA Union Effects in the Price/Quantity Adjustment Process

The only requirement for cost minimisation is that the market equations in (60) hold. The labour and production markets can interact bi-directionally: production fundamentals might alter labour prices, or labour prices might alter production fundamentals. If the labour market is non-competitive, and unions can exploit the lack of competition to set labour prices, then DHB production-based marginal productivities need to adjust to changing labour prices in the labour market. Adjustment occurs through altering the quantities of inputs used in production, until balance is once again achieved between labour prices and input marginal productivities.

If the unions' monopoly face can increase wages, then from equation (60), either the quantity of labour needs to reduce to rebalance the two markets, or the volume of capital needs to increase to make labour's marginal revenue product again equal the higher labour-market-set labour price. Any middle ground, involving less labour and more capital, is also feasible to rebalance the markets, with the adjustment to labour and capital reflecting the ratio of the labour and capital production coefficients α and β.

When balance between the marginal input products and the input market costs is achieved, the effect of different quantities of capital and labour employed in production because of the rebalancing ***is*** the loss of allocative efficiency described in section 3.5.1.

7 Exploratory Regression Analysis

Sharing both monthly time-series and cross-sectoral DHB characteristics, this thesis uses panel data as the basis for its econometric analysis. Panel data analytical issues include potential hetroscedasticity across the DHB dimension, and auto-correlated errors across the time dimension. Naive CD, CES and BC production models are used to explore DHB production processes. When the system-of-equation regressions are estimated, more detailed analysis is included to explore hetroscedasticity and auto-correlation issues.

All analysis in this thesis (indeed, the thesis itself) has been undertaken and written using the R statistical language.[47] R is a sophisticated statistical modelling language with built-in capability for modelling and testing relationships across panel datasets, either through its “Linear models for Panel Data” library[48], or through its “Linear and Non-linear Mixed Effects Models”[49] package, which allows the user to test for and model the separate time-series and cross-sectional components.

7.1 Single Equation Cobb-Douglas Health-Service Production

Table (6) starts off with a very simple two input linearised Cobb-Douglas model as defined in equation (22) (“Two Inputs”), together with a variation which includes a “Tertiary” DHB dummy variable (“Two-Tertiary”). Table (6) also reports two more sophisticated single equation production functions that include the multiple labour measures (“Multiple”), and the multiple labour measures with a tertiary provider split (“Multiple-Tertiary”).

The “Tertiary” dummy allows different DHBs to suffer from diseconomies of scale related to their size,[50] recognising DHB scale-of-production cost difference has long been a feature of New Zealand’s health funding environment.[51]

The “Tertiary” dummy variable identifies the following DHBs as “Tertiary”: Auckland DHB, Canterbury DHB, Capital & Coast DHB, Counties Manukau DHB, Waikato DHB, Southern DHB, and Waitemata DHB.

[47] http://www.r-project.org/
[48] http://cran.stat.auckland.ac.nz/web/packages/plm/index.html
[49] http://cran.stat.auckland.ac.nz/web/packages/nlme/index.html
[50] See Figure(10)
[51] http://www.adhb.govt.nz/news/Events/Tertiary%20Services%20Conference/2011/Presentations/7_Ajit_conf_28_1111_Paul_Howa

Table 5: Cobb-Douglas Production Function: With / Without Tertiary

	Dependent variable:			
	log(Scaled_Monthly_Output)			
	Two Inputs	Two-Tertiary	Multiple	Multiple-Tertiary
	(1)	(2)	(3)	(4)
log(Capital_Quantity_Estimate)	0.341*** (0.023)	0.562*** (0.045)	0.379*** (0.018)	0.526*** (0.033)
log(All_Labour)	0.629*** (0.025)	0.417*** (0.042)		
Tertiary		1.974*** (0.562)		2.866*** (0.674)
log(Capital_Quantity_Estimate):Tertiary		-0.368*** (0.056)		-0.363*** (0.061)
log(All_Labour):Tertiary		0.194*** (0.065)		
log(Medical_Labour):Tertiary				-0.269*** (0.100)
log(Nursing_Labour):Tertiary				-0.292* (0.176)
log(Allied_Health_Labour):Tertiary				0.200** (0.091)
log(Support_Labour):Tertiary				-0.086(0.087)
log(ManAdmin_Labour):Tertiary				0.546*** (0.107)
log(Medical_Labour)			0.601*** (0.034)	0.596*** (0.035)
log(Nursing_Labour)			0.256*** (0.051)	0.259*** (0.056)
log(Allied_Health_Labour)			0.008(0.041)	0.061(0.057)
log(Support_Labour)			0.111*** (0.016)	0.061*** (0.017)
log(ManAdmin_Labour)			-0.525*** (0.042)	-0.673*** (0.053)
Constant	1.891*** (0.070)	1.533*** (0.136)	4.001*** (0.114)	3.565*** (0.189)
Observations	515	515	524	524
R^2	0.965	0.968	0.981	0.983
Adjusted R^2	0.965	0.967	0.980	0.983
Residual Std. Error	0.166 (df = 512)	0.159 (df = 509)	0.124 (df = 517)	0.116 (df = 510)
F Statistic	7,005.093*** (df = 2; 512)	3,040.321*** (df = 5; 509)	4,374.809*** (df = 6; 517)	2,318.714*** (df = 13; 510)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6: Cobb-Douglas Production Function: With / Without Tertiary

TRUE

7.1.1 Single Equation Cobb-Douglas Regression Results

With a labour input factor intensity coefficient of 0.63, and a total elasticity of scale estimate of 0.970, Model 1 in Table (6) describes labour as the input contributing most to DHB health-service production, a process which displays constant returns-to-scale. The model is statistically significant and, with an R^2 value of 0.965, a simple two input Cobb-Douglas model explains a very high proportion of the variation in output.

Model 2 in Table (6) expands Model 1 through separating out tertiary from secondary health-service providers. The tertiary split has generated significant differences in both the input factor intensity and the elasticity of scale between secondary and tertiary providers. Adding an additional unit of capital to secondary providers generates almost 35%[52] more output than adding an additional unit of labour. In contrast, for "capital rich" tertiary providers, an additional unit of labour would generate more than 315% as much output as an additional unit of capital.[53]

Secondary care providers, with an elasticity of scale (σ) of 0.979, show constant returns-to-scale. In contrast, $\sigma = 0.805$ for tertiary providers, indicating tertiaries suffer from decreasing returns-to-scale.

7.1.2 Single Equation Cobb-Douglas: Multiple Inputs with Tertiariness

Models 3 and 4 in Table (6) extend the CD production model through expanding the number of labour inputs used in production (Model 3), and modelling "tertiariness" (Model 4). Model 3's capital coefficient remains similar to Model 1; however, the sum of the labour coefficients decreases[54], and Model 3 as a whole is characterised by decreasing returns-to-scale.[55]

Model 3 Labour

The Medical workforce has the highest marginal contribution to output (0.601), followed by nursing (0.256), and support labour (0.111). From Model 3, Allied health workers have no statistical impact on health-service production while Management / Administration labour has a negative production function coefficient, close in magnitude to the positive medical coefficient.

From Model 3, each additional FTE unit of Management / Administration labour employed

[52] 0.562 / 0.417 = 1.35 more output

[53] Model 2's tertiary provider labour and capital coefficients are 0.194 and 0.611 respectively

[54] Model 1: Labour = 0.629, compared to $\sum_{i=1}^{5}(L_i) = 0.451$ in Model 3

[55] Model 1: $\sigma = 0.97$ compared to Model 3: $\sigma = 0.83$

in the health-service production process *decreases* health-service output, more than twice as much as each additional FTE unit of nursing labour *increases* health-service production. One additional manager offset the positive production effects of two additional employed nurses. This quite amusing result, that Management / Administration personnel negatively affect production, is explored further when labour is estimated within a system-of-equations.

Model 4 Labour

Model 4 continues Model 2's analysis of secondary / tertiaries factor intensities.[56]

Within secondary providers, the medical workforce makes the strongest contribution to health-service production. Each additional medical worker contributes approximately 230% more output as an additional nursing worker[57], suggesting secondary providers might be "medical workforce poor" and relatively "nursing workforce rich".

The elasticity of scale, $\sigma = 0.83$, suggests decreasing returns-to-scale for secondary care providers is now apparent, while tertiary provider scale diseconomies, at $\sigma = 0.556$, worsen. The size of the tertiary nursing and support workforce production coefficients suggests "too many" support and nursing workforces are employed within Tertiary providers for Tertiary provider's scale of production.[58]

From Model 4, increasing the medical workforce would make the highest contribution to increases in both secondary and tertiary health service output.

Model 4 continues Model 3's surprising management / administration workforce story: in both secondary *and* tertiary providers, management / administration staff *decrease* health-service production.[59]

[56]

Model 2 Secondary Provider: Capital = 0.562, Labour = 0.417
Model 4 Secondary Provider: Capital = 0.526, $\sum_{i=1}^{5}(L_i) = 0.304$
Model 2 Tertiary Provider: Capital = 0.195, Labour = 0.611
Model 4 Tertiary Provider: Capital = 0.163, $\sum_{i=1}^{5}(L_i) = 0.403$

[57]Nursing = 0.259, medical = 0.596, so 0.596 / 0.259 = 2.30 more per unit output from an additional medical labour compared to additional nursing labour

[58]Tertiary nursing coefficient equals -0.033, support workforce equals -0.025

[59]Secondary care provider Management and Admin equals -0.673, while tertiary provider Management and Admin equals -0.127.

7.2 Single Equation Constant Elasticity of Substitution (CES)

The R statistical language incorporates functionality to estimate single equation Constant Elasticity of Substitution (CES) production functions using a variety of estimation methods. The minEconCES library[60] estimates the following CES functional form:

$$Y = \gamma\big(\delta K^{-\rho} + (1-\delta)L^{-\rho}\big)^{-\nu/\rho} \tag{61}$$

where:

Y = a quantity measure of economic output produced within a specific time period,

L = a quantity measure of labour used in the production of Y,

K = a quantity measure of physical capital used in the production of Y,

δ = the relative labour factor intensity used in the production,

γ = Hicksian-neutral technological growth,

ν = returns-to-scale factor. Under the assumption of homotheticity, ν is equal to 1, but within micEconCES, the value of ν is free to vary.

$\sigma = 1/(1+\rho)$

7.2.1 micEconCES Optimisation Methods

[Henningsen and Henningsen(2011)] outline the properties of the different estimation algorithms:

- Levenberg-Marquardt (LM)

  The LM is an iterative algorithm which performs an optimal interpolation between a first-order Taylor series approximation (Gauss-Newton method) and a steepest-descend method (gradient method).[61] Unlike other optimisation methods, LM estimates a local optimal solution for the CES parameters. Researchers have found the LM outperforms other optimisation methods for estimating CES parameters based on Monte-Carlo simulation experiments. [Henningsen and Henningsen(2011)] note the LM algorithm performs as poorly as the other methods in estimating the elasticity of substitution, which means that the estimated elasticity tends to be biased towards infinity, unity, or zero.[62]

[60] [Henningsen and Henningsen(2011)]
[61] [Henningsen and Henningsen(2011)] at page 9
[62] [Henningsen and Henningsen(2011)] at page 10

- Conjugate Gradients (CG)

  Like LM, CG is an iterative algorithm but works best for objective functions that are approximately quadratic. CG is sensitive to objective functions that are not well-behaved or have a non-positive semi-definite Hessian. [Henningsen and Henningsen(2011)] note that since the CES function has only few parameters and the objective function is not approximately quadratic around the minimum, the CG method is probably less suitable than other algorithms for estimating a CES function.

- Newton

  The Newton method employed within micEconCES is based on a variation of the traditional Newton iterative optimisation method. The Newton method tests the first and second derivatives of the objective function to determine the direction of a shift vector representing the next optimal estimate and iteratives between the first and second derivative estimates until a stationary point is found when the objective function's second derivatives are almost zero. The Newton method estimates local maximum/minimum optimal values.

- Broyden-Fletcher-Goldfarb-Shanno (BFGS)

  The BFGS algorithm is a variation of the Newton approach; however, uses a special procedure to approximate and update the Hessian matrix of the objective function in every iteration. [Henningsen and Henningsen(2011)] note that BFGS may not converge in estimation if the current parameters are close, but not sufficiently close to the minimum. If the current parameters are near the minimum, the Hessian may not be close enough to achieve convergence. However, [Henningsen and Henningsen(2011)] also note that in practice when BFGS does converge, its estimates are robust and "super-linear".

- Nelder-Mead (NM)

  Unlike the above algorithms, the NM method is designed to find a global maximum/minimum of an objective function. The NM uses a "downhill simplex algorithm", which makes NM more tolerant to objective functions which are not well-behaved at the cost of a slower estimation speed. The advantage of the NM algorithm is its robustness: the algorithm will almost always converge, producing CES parameters; however, [Henningsen and Henningsen(2011)] note that as a result of its heuristic optimisation technique, NM results should be handled with care.[63]

[63] [Henningsen and Henningsen(2011)] at page 17

- Simulated Annealing (SA)

  [Henningsen and Henningsen(2011)] describe the SA algorithm as a robust global optimiser that can be applied to a large search space and provides fast and reliable solutions. SA chooses a random solution close to the current solution, while the probability of the choice is driven by a global parameter which decreases as the algorithm progresses.

- Differential Evolution (DE)

  The DE algorithm belongs to an 'evolutionary' class of algorithms whose solution cannot be proven analytically. For some problems, DE has proven to be more accurate and more efficient than Simulated Annealing, Quasi-Newton, or other genetic algorithms described above.[64] [Henningsen and Henningsen(2011)] note the algorithm has proven to be effective and accurate on a large range of optimisation problems.

- Byrd, Lu, Nocedal, and Zhu (L-BFGS-B)

  The L-BFGS-B optimisation method is a variation of the BFGS method described above, however, L-BFGS-B allows for constraints on the optimisation parameters. The L-BFGS-B algorithm is well suited for high dimensional optimisation problems, and copes well with the CES low dimensionality.

- PORT routines

  The PORT routines are a variation on Newton's optimisation method, allowing users to specify constraints on the parameter space within which optimisation occurs.

- Kmenta approximation

  The Kmenta approximation method is a linearised first order Taylor's Expansion of the non-linear CES function which is estimated using ordinary least squares. micEconCES estimates the first order component of the Taylor's Expansion only. The remaining unestimated orders therefore bias the resulting regression through acting as omitted variables.

7.2.2 Two input CES

The following table of results was derived through estimating equation (61) as a single CES production function using the methods described in subsection 7.2.1 above.

[64] [Henningsen and Henningsen(2011)] at page 21

Method	Gamma	Delta	Rho	Nu	Elasticity
BFGS	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Conjugate Gradients	4.455	0.398	0.298	1.015	0.77
95% CI	3.518 - 5.392	0.174 - 0.622	-0.245 - 0.841	0.994 - 1.036	
Kmenta	8.01	0.119	-1.312	0.968	
95% CI	5.65 - 10.369	-0.206 - 0.443	-6.216 - 3.591	0.952 - 0.985	
L-BFGS-B	9.827	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Levenberg-Marquardt	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Nelder-Mead	8.873	0.136	-0.511	0.962	2.046
95% CI	7.369 - 10.377	0.02 - 0.252	-1.064 - 0.041	0.943 - 0.981	
Newton	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
PORT	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Simulated Annealing	5.01	0.473	0.536	0.997	0.651
95% CI	3.941 - 6.079	0.23 - 0.716	-0.039 - 1.111	0.976 - 1.017	

With the exception of the CG and the SA algorithms, $\nu < 1$ with a 95% confidence interval for all of two input CES functions, indicating production suffers from decreasing returns-to-scale. The value of δ, the capital factor intensity, in most instances is approximately 0.14, suggesting the labour factor intensity is approximately 0.86 and health-service production is a labour intensive production process. Compared to the CD production processes of Model 1 in Table (6), labour has increased in its factor intensity, with capital playing a less important production role. Again, with the exception of CG and SA algorithms, $\rho < 1$ resulting in $\sigma > 1$ for almost all variations of the two input CES function, suggesting capital and labour are highly substitutable for each other in the production process.

Both the CG and SA algorithms suggest capital plays a more important role in production than the other CES algorithms, and that the inputs into health-service production are not high substitutes for each other. In contrast to the other CES algorithms, labour's factor intensity within the CG CES model is approximately 0.60, with capital being 0.4, similar in size to the Model 1's results in Table (6). The SA algorithm suggests production is more balanced still, with capital's factor intensity being 0.47 and labour 0.53.

Both the CG and SA algorithms identify $\sigma < 1$, suggesting substitution exists between the inputs into health-service production, but unlike the other algorithms, capital and labour are not highly substitutable for each other. With $\sigma = 0.77$ for the CG algorithm, capital and labour can be relatively easily substituted for each other within the production process. The SA algorithm, with $\sigma = 0.65$, suggests substitution is possible, however, more difficult than estimated within the CG algorithm.

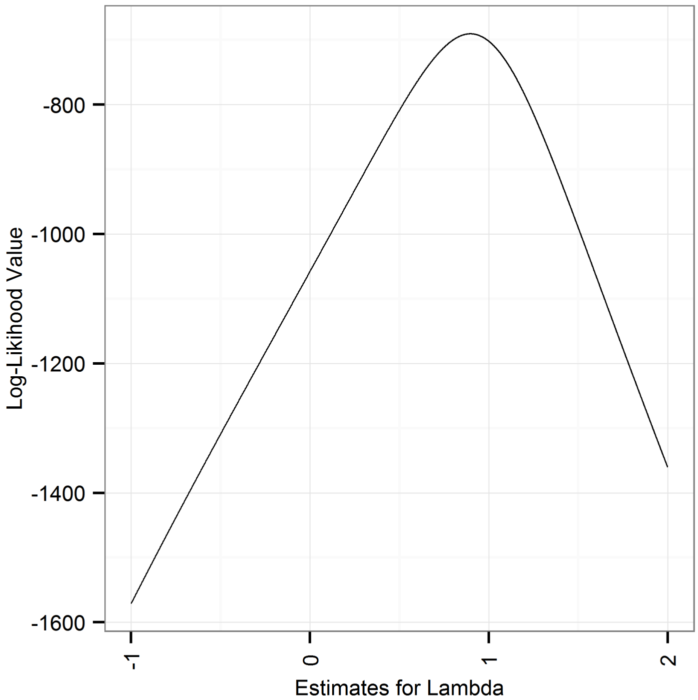
7.3 Single Equation Box-Cox Production Function

[Bairam(1994)] describes a modification of the Cobb-Douglas / CES production function that employs a Box-Cox transformation on its input and output variables.

$$\frac{Y^{\lambda} - 1}{\lambda} = A(t) + \alpha \left(\frac{L^{\lambda} - 1}{\lambda} \right) + \beta \left(\frac{K^{\lambda} - 1}{\lambda} \right) \tag{62}$$

Bairam's Box-Cox transformation has the advantage of encapsulating both Cobb-Douglas and CES technology within its parameters when $\lambda = 0$ or $\lambda < 1$, respectively. Figure 18 below presents the results of a grid search for λ whose estimated value is 0.897. From equation (53), $\lambda = 0.897$ meaning $\sigma = 9.71$, making the underlying technology close to perfect input substitutes.

Figure 18: Grid Search Values for Lamba: BC Production Model



Estimating equation (62) above with the grid-search value of $\lambda = 0; 1; 0.897$ produces the following estimates:

Table 7: Box-Cox Production Function: Cobb-Douglas, Linear and Unrestricted CES

	Dependent variable:		
	BC_Output		
	Lamba = 0 (CD)	Lamba = 1 (Linear)	Unrestricted CES
	(1)	(2)	(3)
BC_Labour	0.025***	0.628***	0.474***
	(0.005)	(0.025)	(0.022)
BC_Capital	0.352***	0.341***	0.350***
	(0.020)	(0.023)	(0.024)
Constant	0.002	0.030***	0.013***
	(0.002)	(0.008)	(0.004)
Observations	515	515	515
R^2	0.873	0.965	0.959
Adjusted R^2	0.872	0.965	0.959
Residual Std. Error (df = 512)	0.031	0.0002	0.008
F Statistic (df = 2; 512)	1,753.626***	6,995.537***	6,059.469***
Note:			*p<0.1; **p<0.05; ***p<0.01

Of the three models in Table (7), the perfect substitutes specification has both the highest fit to the data, and highest overall model F-Statistic. The estimated input factor intensities for the perfect substitute model are close to the factor intensity for both Model 1 in Table (6) and the values generated by the CG CES algorithm.

7.4 CES System-of-Equations: Two factors-of-production

The non-linear CES two factors system-of-equations described in the systems-of-equations (59) was estimated using the nlsystemfit function in the systemfit library of the R statistical language, with less than impressive effect. Regardless of starting values past to the non-linear estimation function, unfortunately the system would not converge.

The specification of the system as a two input production function with labour and capital marginal productivities defining DHB Provider Arm demand for labour and capital was described in R within the following code which failed to converge to an estimatable solution:

```
kk <- Scaled_Monthly_Output ~ Hicks_Neutral_Tech_Progress * (Delta*(All_Labour^(-Rho)) * (1-
mm <- log(Capital_Cost)     ~ KapLabourVar * log(All_Labour) + KapCapitalVar * log(Capital_C
ll <- log(Labour_Cost)      ~ LabourCapVar * log(All_Labour) + LabLabourVar  * log(Capital_C
system <- list( Production = kk, LabourMarket = ll, CapitalMarket = mm)
start.values <- c(Hicks_Neutral_Tech_Progress=1, Delta = .7, Rho = .3,
                  KapLabourVar = 10, KapCapitalVar = -10,
                  LabourCapVar = 10, LabLabourVar = -10)
CES <- nlsystemfit(method    = "SUR",
                   eqns      = system,
                   startvals = start.values,
                   data      = Two_Input_Econometric_Frame,
                   maxiter=1000)

## Error in qr.solve(t(X) %*% SI %*% X, tol = solvtol):  singular matrix 'a' in
solve
```

7.5 CD system-of-equations: Two Inputs

With the failure of the nonlinear CES system-of-equations to solve, a linearised CD system-of-equations was estimated. The linear nature of the functional specification ensures the system will converge to an solution in estimation.

Table (8) expands out the CD modelling introduced in Table (6). Table (8) contains two system-of-equations of a CD production function with two inputs of capital and labour, with the second system-of-equation modified to allow tertiary providers differences to operate in both the production and the input markets.

rotating

The two input-only production functions of Tables (8) and (6) are equivalent; however, the inclusion of the labour and capital input market dimensions identify significant differences between secondary and tertiary providers within both the input markets. In the labour market, secondary care providers have a correctly signed and low price elasticity of labour demand; however, tertiary labour demand is incorrectly signed. Average labour costs decline with increasing secondary care labour employment, as expected from decreasing labour productivity. Conversely, labour costs increase with secondary care capital inputs, reflecting the effects of increases in scale.

In the capital market, secondary care providers have no statistically significant impact on capital costs: regardless of their scale of operation, secondary provider production fundamentals have no impact on the capital costs they face.

In contrast, tertiary provider labour costs *increase* with both labour and capital inputs. Tertiary providers face *increases* in capital costs with scale: capital costs increase both their workforce size and their capital inputs increase.

Table 8: Cobb-Douglas System-of-Equations: Two Input System with Tertiary

	Production	Labour Market	Capital Market	Production (Tertiary)	Labour Market (Tertiary)	Capital M
(Intercept)	**1.891***	**4.517***	**−0.010***	**1.533***	**4.505***	
	[1.755; 2.028]	[4.423; 4.611]	[−0.019; −0.001]	[1.266; 1.799]	[4.336; 4.674]	[−0.
log(All_Labour)	**0.629***	**−0.170***	**0.006***	**0.417***	**−0.397***	
	[0.581; 0.678]	[−0.203; −0.136]	[0.003; 0.009]	[0.334; 0.500]	[−0.450; −0.344]	[−0.
log(Capital_Quantity_Estimate)	**0.341***	**0.139***	**−0.004***	**0.562***	**0.330***	
	[0.295; 0.386]	[0.107; 0.170]	[−0.007; −0.001]	[0.475; 0.649]	[0.275; 0.386]	[−0.
Tertiary				**1.974***	**−1.449***	−
				[0.872; 3.075]	[−2.147; −0.751]	[−0.3
log(All_Labour):Tertiary				**0.194***	**0.452***	
				[0.068; 0.321]	[0.371; 0.532]	[0.0
log(Capital_Quantity_Estimate):Tertiary				**−0.368***	**−0.235***	
				[−0.477; −0.258]	[−0.304; −0.166]	[0.0
R^2	0.965	0.168	0.031	0.968	0.355	
Adj. R^2	0.965	0.164	0.027	0.967	0.348	

* 0 outside the confidence interval

8 Cobb-Douglas System-of-Equations: Multiple Inputs

Table (9) is the final extension of the system-of-equations models, capturing all five labour inputs plus capital, and all five labour inputs plus capital with production separated out by secondary / tertiary.

A Cobb-Douglas production function, split by secondary/tertiary DHB Provider, was estimated for five labour and one capital input into the health service production process. With an R^2 value of 0.98, the production function has an extremely high fit to the data. Both secondary and tertiary providers show indications of decreasing returns-to-scale.[65]

The actual and expected modelling results from Table (9) are graphed in section (8.4).

8.1 Heteroscedastic and Serially-Correlated Errors

Figures (19)-(32) present the auto-correlation functions (ACF) and the model residuals from the system-of-equations estimated from Table (9). Panel data, with its time-series and cross-sectional properties, is prone to serially-correlated and heteroscedastic errors.

The ACF functions enable serial-correlation within the model residuals to be visually ascertained for each DHB Provider Arm modelled equation from Table (9). Similarly, a plot of the residuals over time can be used to identify the extent of any heteroscedasticity issue.

Focusing on the ACF function first, the following DHBs show significant auto-correlation spikes at the non-zero frequency:

- ACF Production Function: Southern, Taranaki, Waitemata and Whanganui.
- ACF Medical Labour Market: Southern, Taranaki, and Waikato
- ACF Nursing Labour Market: Taranaki
- ACF Allied Health Labour Market: Hutt Valley, MidCentral, Nelson-Marlborough, and Taranaki
- ACF Support Labour Market: Canterbury, Capital and Coast, Southern, Taranaki, and Whanganui. Both Southern and Whanganui show significant serially-correlated errors.

[65] The sum of the production coefficients, $\sigma = 0.83$ for secondary care, and $\sigma = 0.49$ for tertiary providers.

- ACF ManAdmin Labour Market: Canterbury, Nelson-Marlborough, Taranaki, West Coast, and Whanganui. Both the West Coast and Whanganui show significantly serially-correlated errors.

- ACF Capital Market: All DHBs show significant errors.

The ACF Capital Market plots show significant serial-correlation across all DHBs, suggesting the capital model might be significantly misspecified in the system-of-equations model. Individually, Southern, Taranaki and Whanganui DHBs all display mild degrees of serial-correlation within their production model errors. For Taranaki, data issues affect the labour measures through the HWIP data source, suggesting Taranaki's results should be viewed with caution.

Examining the residual plots, the following DHBs show issues with their residuals.

- Production Function Residuals: Southern, Tairawhiti, Whanganui, and Waitemata

- Medical Labour Market Residuals: Southern, Taranaki, Waikato

- Nursing Labour Market Residuals: Taranaki, Tairawhiti, and Nelson-Marlborough

- Allied Health Labour Market Residuals: Capital and Coast, Taranaki, West Coast

- Support Labour Market Residuals: Capital and Coast, Whanganui, Southern. Southern looks like it has a level shift in its errors.

- ManAdmin Labour Market Residuals: Canterbury, West Coast, and Whanganui. Both the West Coast and Canterbury show strong serial-correlation.

- Capital Market Residuals: All DHBs show significant errors.

Again, the Capital Market Residuals look particularly suspect, confirming its results ought to be viewed with caution. Southern and Whanganui DHBs residuals suggest thier results ought to be treated with some caution.

8.2 Health Sector Labour Markets

Across the labour markets, the coefficients of the own labour variables are either negatively signed, or statistically insignificant, as would be expected from diminishing marginal returns for each input. The own-input signs for both medical and the nursing labour demand are price-inelastic, medical (-0.396) more than nursing (-0.486). Support labour demand is also price inelastic (-0.593), but less inelastic than nursing and medical labour. Allied Health's labour demand elasticity is not statistically different from zero, and ManAdmin labour demand is *price-elastic* (-1.105).

The high medical and nursing labour price inelasticity creates the potential for unions to exploit their "monopoly face": lifting both labour prices, and reducing employed workforce volumes, compared to a competitive labour market outcome. If the medical workforce expanded by 10%, then medical labour costs would only fall by 3.96%. If medical labour costs increased by 10%, then only 4% fewer medical workforce would be employed. If the nursing workforce increased by 10%, then nursing labour costs would fall by 4.86%. If nursing labour costs increased by 10%, then 5.1% fewer nurses would be employed. If ManAdmin employed labour expanded by 10%, then their labour costs would fall by 11%. If ManAdmin tried to increase their labour costs by 10%, then 11% of their workforce would become unemployed.

8.3 Health Service Production and Labour Market Comparative Statics

The structure of the system-of-equation modelling introduces a rich depth of complexity to modelling comparative static changes since now disturbances to either the production or the labour markets "perturb" through the production/labour market system. The inter-related nature of the production function induces secondary labour market price effects within other workforces. The DHB Provider Arm average monthly values for the inputs into production for the 2011 financial year, separated by secondary/tertiary provider, were used to undertake comparative static analysis of Table (9) results.[66]

The structure of Table (9) implies changes in workforce size and composition have separate effects on secondary and tertiary provider output depending on the relative sizes of each workforce and their production function coefficient. However, the labour market impacts reflect the size of the combined workforces and changes in secondary/tertiary workforce "equilibrate" within the single labour market which responds to total workforce size.

[66]The values for the inputs were:
Secondary Providers: Capital = 4829.987, Medical Labour = 150.5, Nursing Labour = 510.08, Allied Health Labour = 206.21, Support Labour = 122.57, ManAdmin = 322.9883
Tertiary Providers: Capital = 23068.1, Medical Labour = 681.73, Nursing Labour = 1994.41, Allied Health Labour = 950.85, Support Labour = 444.58, ManAdmin = 1100.27

8.3.1 Medical Labour +/- 10%

Medical labour makes the largest contribution to health-service volume production for both secondary and tertiary providers; however, the output volume impact of medical labour change differs between providers. Increasing medical labour for both secondary and tertiary providers by 10.0% increases health service output by 6.0% and 3.6% for each provider, respectively, reflecting the higher medical labour productivities for secondary providers. Total Provider Arm health-service output increases by 4.1%.

In the labour market, 10% more medical labour *decreases* medical labour prices by 3.7%, while inducing smaller labour price increases for the less expensive nursing (0.5%), support (3.9%) and ManAdmin (3.8%) workforces. DHB Provider Arm medical costs - the combined price and volume effects of the 10% increase in medical labour - increase 5.9% across both secondary and tertiary providers. Across all DHBs, the total labour costs over all workforces increase 2.5%.

Decreasing medical labour by 10% in secondary and tertiary care results in a disproportionate fall in the respective provider output volumes. Secondary care output decreases 6.2% and tertiary output declines 3.9%. With few medical workforce available, medical labour prices *increase* by 4.3%. Nursing, support and ManAdmin labour prices fall 0.5%, 4.1% and 4.1% respectively. Allied health labour prices are relatively unaffected.

DHB Provider Arm medical costs, in total, fall 6.2% through the combined price and quantity effects. Across all DHBs, total labour costs decrease 2.6%.

Transmitting Costs Through the Labour Market

If the tertiary provider medical workforce alone decreases 10%, tertiary provider output would fall 3.9%. However, decreasing the tertiary medical workforce in tertiary providers puts pressure on the national medical labour market, increasing total medical labour prices by 3.4%. The medical labour cost inflation, originating within the tertiary-employed workforce, induces labour price changes over all of the other workforces.

Secondary providers, despite no change occurring to employed workforce volumes, experience the labour price inflation transmitted through the labour market from the decrease in the tertiary medical workforce. Secondary provider medical workforce costs, the combined price and volume effects, increase 3.4% purely through the inflation stemming from the medical labour market and the decrease in tertiary employed medical labour.

Total workforce costs across all DHB Provider Arms decrease 2.2%, however, tertiary provider total workforce costs fall 2.7% and secondary provider total workforce costs *increase* 0.3% purely through transmitted inflation effects.

8.3.2 Nursing Labour +/- 10%

Table (9) indicates tertiary providers show signs of their nursing workforce being "too large", while secondary providers have scope for more nursing employment within their workforces.

Increasing the tertiary nursing workforce, *ceteris paribus*, results in a 2.1% *decline* in tertiary health service production; however, a 10% increase in secondary care nursing increases secondary care output by 2.6%, resulting in a total decline in health service output of 1.1% across all DHBs. In the labour markets, all workforces except for the support workers experience a decline in labour prices, with allied health and nursing itself experiencing the largest decreases.[67] Medical labour prices fall 1.4%.

DHB Provider Arm nursing costs, in total, increase 5.0% through the combined price and quantity effects from the 10% increase in employed nurses. Across all DHBs, total labour costs increase 0.4%. A 10% decrease in the employed nursing workforce size decreases total nursing costs by 5.3% through price and quantity effects. Total DHB labour costs would also decline 0.2%.

If the nursing workforce was rebalanced with no change in the total workforce size through tertiary providers decreasing their nursing workforce by 10%, and secondary providers increasing their nursing workforce by 39%, then **IF** such a change did occur, nationally, total health service output would increase by 3.9% with no added increase in DHB Provider Arm costs. Since the labour market size remains unchanged, there would be *no*[68] pressure on labour cost inflation across the workforces. Secondary provider output would increase by 9.4%, and tertiary output would increase by 2.4% for no net increase in labour costs across all DHB Provider Arms.

[67] Allied health declines 6.9%, and nursing declines 4.5%

[68] Excluding migration transaction costs.

8.3.3 Allied Health Labour +/- 10%

Changing the allied health workforce employed within DHB Provider Arms has a significant effect on the labour prices of virtually all other health workforces. A 10% increase in both the secondary and tertiary provider allied health workforces generates a 2.2% increase in total health services produced within DHBs. However, increased allied health labour induces a 3.4% increase in medical labour prices, a 2.7% increase in nursing labour prices, a 3.8% increase in ManAdmin prices and a negligible 0.7% increase in allied health own-labour price. Only support labour's price falls 6.0%.

DHB Provider Arm allied health costs, in total, increase 10.8% through the combined price and quantity effects. Across all DHBs, total labour costs increase 4.1%.

In contrast, a 10% reduction in allied health workforce has an opposite effect on providers: total output falls 2.4%, medical labour prices fall 3.7%, nursing labour price falls 2.9%, ManAdmin labour price falls 4.0%, allied health labour price falls 0.8% and support labour prices increase 7.1%. DHB Provider Arm allied health costs, in total, decrease 10.7% through the combined price and quantity effects. Across all DHBs, total labour costs decrease 4.3%.

Allied health seems to be a workforce which has significant inter-dependencies with other health sector workforce groups, such that changing the number of allied health workers employed within DHBs induces significant labour inflation within other workforce groups. Allied health has a significant private sector market[69] outside of MECAs which might organise health service delivery at lower cost.

8.3.4 Support Labour +/- 10%

As expected with a workforce that "supports" health care delivery, altering the size of the support workforce +/- 10% has little effect on the volume of health services delivered nationally. A 10% increase in support workers nationally would increase health service output by 0.7%. However, within the labour market, medical, allied health and ManAdmin labour prices would all increase 1.3%, 2.1% and 1.4% respectively. Support worker own-labour price would decline 5.5%.

DHB Provider Arm support costs, in total, would increase 3.0% through the combined price

[69]See Appendix (A.1.3)

and quantity effects of the 10% support worker change. Across all DHBs, total labour costs increase 2.3%, mainly through large induced effects occurring within tertiary providers.

8.3.5 Management and Administration Labour +/- 10%

Management and administration labour (ManAdmin) are negatively signed within both secondary and tertiary production functions, suggesting ManAdmin labour *decrease* the volume of health-services produced by DHBs. However, ManAdmin are also negatively signed in the labour market functions suggesting ManAdmin play a role in affecting labour market prices for different health-sector workforces. While the ManAdmin workforces do not directly produce health care, Table (9) suggests they actively decrease the cost of employing other workforces, potentially through improving workforce co-ordination, and generating workforce efficiencies.

A 10% increase in ManAdmin labour would *decrease* secondary provider production by 6.5% and tertiary production by 1.8%. However, in the labour market, a 10% increase in employed ManAdmin labour *decreases* medical labour prices by 3.7%, nursing labour prices by 1.7% and ManAdmin prices by 10.0% for all providers.

Increasing the ManAdmin workforce decreases secondary provider output by the largest proportion; however, contributes to the tertiary provider labour cost savings the most. Tertiary output declines 1.8%, but total labour costs across all workforce groups employed by tertiary providers decrease 3.0%. For secondary providers, output falls 6.5%, and total labour costs decline by a smaller 1.8%.

Contrary effects are noticeable for a 10% reduction in ManAdmin labour. Secondary provider output *increases* 7.7%, and tertiary provider output increases 2.1%. Within the labour market, medical, nursing and ManAdmin labour prices increase 4.3%, 2.0% and 12.3%, respectively. Total tertiary provider labour costs, the combined price and quantity effects of the 10% decrease in ManAdmin labour, increase 3.5%. Total secondary provider labour costs increase 2.0%. Total DHB labour costs, across tertiary and secondary providers, increase 3.2%.

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Table 9: Cobb-Douglas System-of-Equations: Multiple Labour Inputs with Tertiary

	Production	Medical LM	Nursing LM	AH LM	Support LM	ManAdmin LM
(Intercept)	**3.722***	**5.846***	**5.403***	**5.783***	**2.698***	**5.619***
	[3.366; 4.079]	[5.498; 6.194]	[5.150; 5.657]	[5.408; 6.157]	[1.579; 3.816]	[5.229; 6.009]
Tertiary	**3.323***	**0.128***	**0.076***	0.056	−0.069	**0.102***
	[2.127; 4.520]	[0.075; 0.181]	[0.037; 0.114]	[−0.001; 0.113]	[−0.239; 0.102]	[0.043; 0.162]
log(Capital_Quantity_Estimate)	**0.485***	**0.253***	**0.126***	**0.214***	−0.141	**0.163***
	[0.424; 0.546]	[0.209; 0.297]	[0.094; 0.158]	[0.167; 0.262]	[−0.282; 0.000]	[0.114; 0.213]
log(Medical_Labour)	**0.607***	**−0.396***	0.049	−0.007	**0.398***	**0.395***
	[0.538; 0.675]	[−0.473; −0.319]	[−0.006; 0.105]	[−0.089; 0.076]	[0.152; 0.644]	[0.309; 0.480]
log(Nursing_Labour)	**0.272***	**−0.146***	**−0.486***	**−0.755***	**0.923***	**−0.234***
	[0.165; 0.380]	[−0.267; −0.024]	[−0.574; −0.397]	[−0.885; −0.624]	[0.533; 1.312]	[−0.369; −0.098]
log(Allied_Health_Labour)	**0.120***	**0.355***	**0.280***	0.072	**−0.652***	**0.391***
	[0.014; 0.227]	[0.264; 0.447]	[0.213; 0.347]	[−0.026; 0.170]	[−0.945; −0.359]	[0.289; 0.493]
log(Support_Labour)	**0.046***	**0.139***	**0.081***	**0.218***	**−0.593***	**0.147***
	[0.013; 0.080]	[0.103; 0.175]	[0.055; 0.107]	[0.180; 0.256]	[−0.707; −0.478]	[0.107; 0.187]
log(ManAdmin_Labour)	**−0.704***	**−0.397***	**−0.184***	0.042	0.058	**−1.105***
	[−0.805; −0.604]	[−0.490; −0.303]	[−0.252; −0.116]	[−0.058; 0.143]	[−0.242; 0.359]	[−1.210; −1.001]
Tertiary:log(Capital_Quantity_Estimate)	**−0.279***					
	[−0.388; −0.170]					
Tertiary:log(Medical_Labour)	**−0.233***					
	[−0.411; −0.056]					
Tertiary:log(Nursing_Labour)	**−0.498***					
	[−0.810; −0.186]					
Tertiary:log(Allied_Health_Labour)	0.137					
	[−0.024; 0.298]					
Tertiary:log(Support_Labour)	0.032					
	[−0.123; 0.186]					
Tertiary:log(ManAdmin_Labour)	**0.509***					
	[0.318; 0.699]					
R^2	0.983	0.628	0.330	0.587	0.238	0.532
Adj. R^2	0.982	0.623	0.321	0.581	0.227	0.525

Note: Coefficients with $p < 0.05$ in **bold**. Figures in brackets are confidence intervals with $\alpha = 0.05$

8.3.6 Auto-correlation Functions of Model Residuals

Figure 19: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Production Residuals

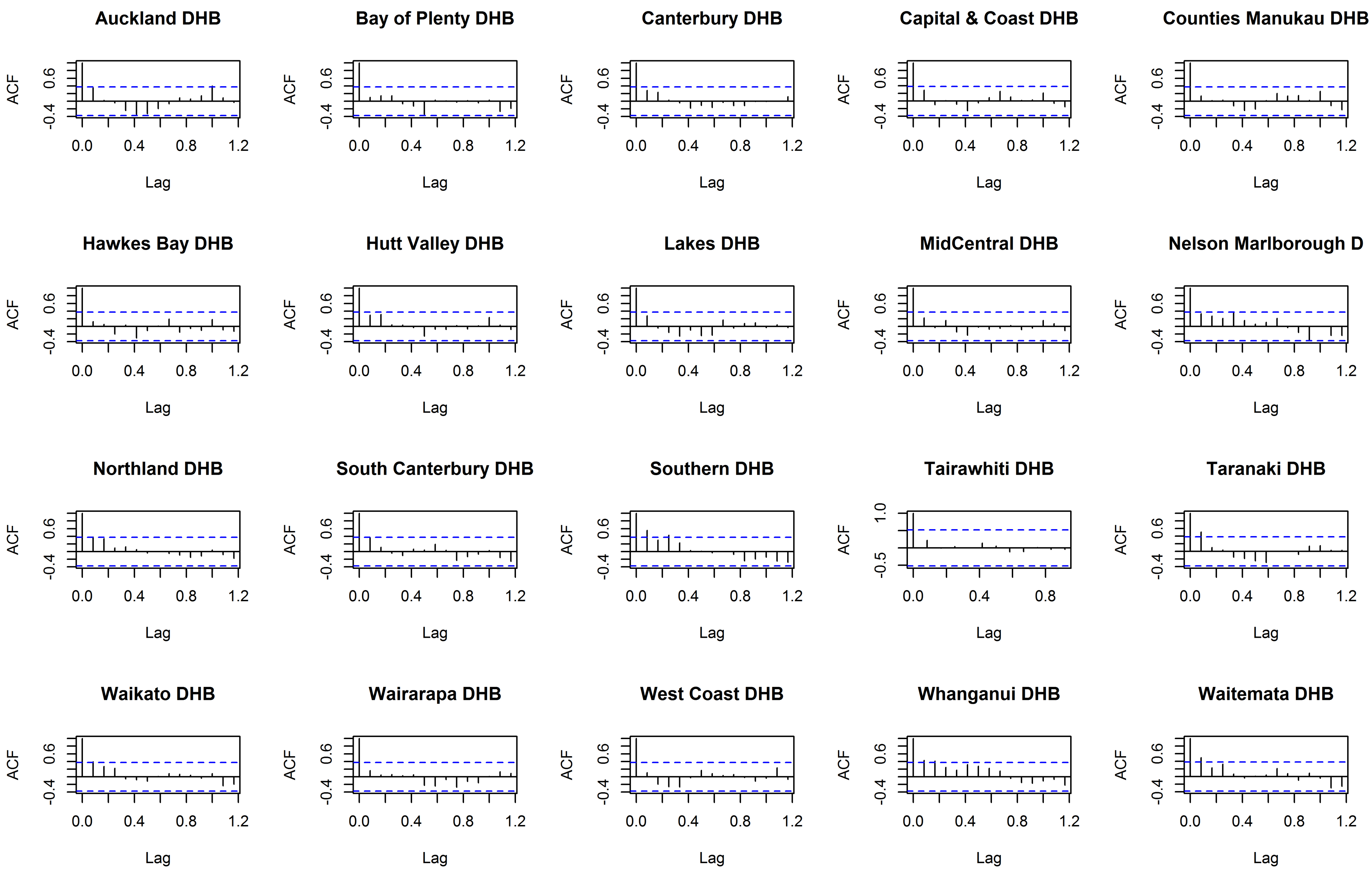


Figure 20: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Medical Labour Cost Residuals

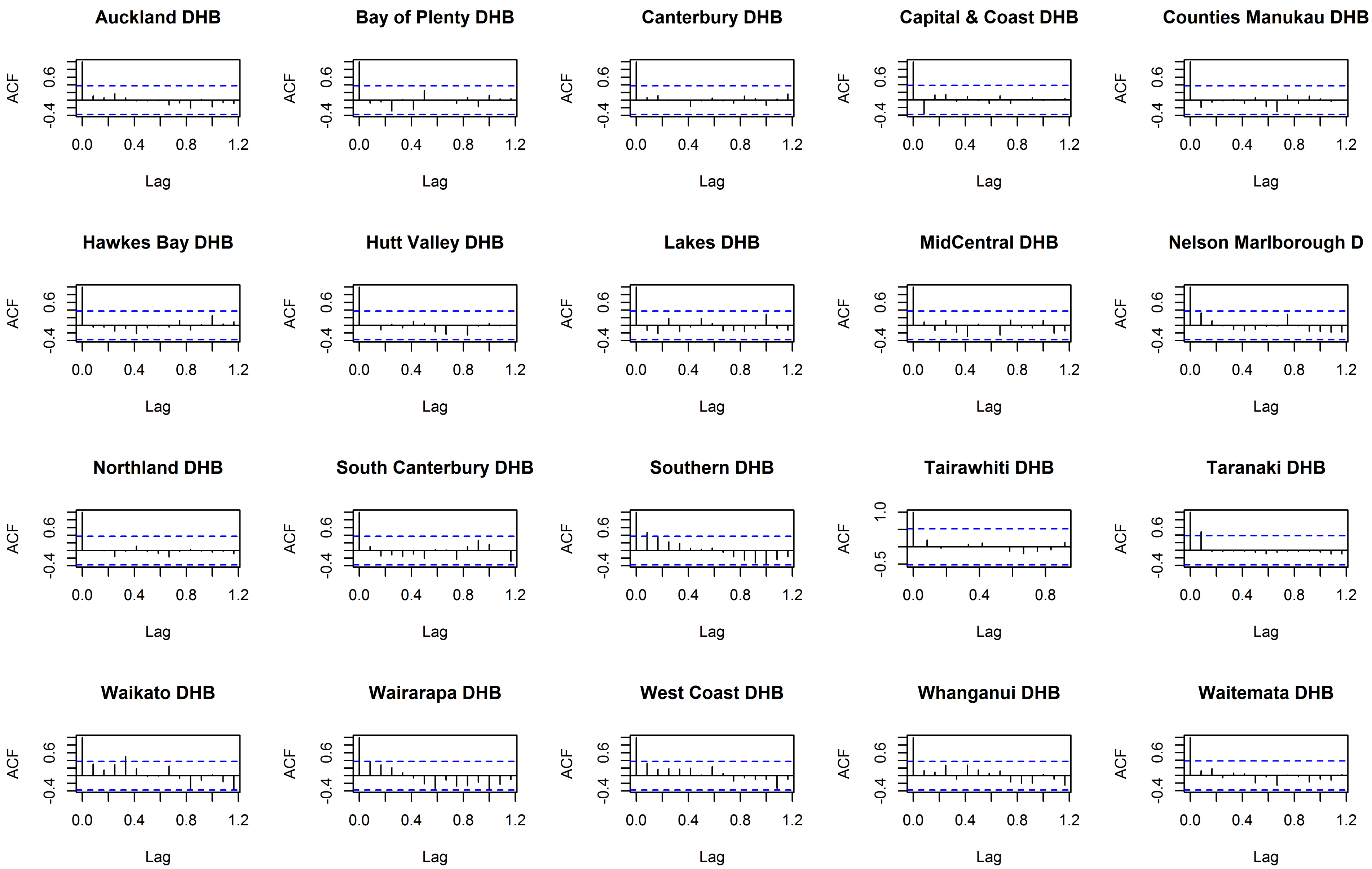


Figure 21: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Nursing Labour Cost Residuals

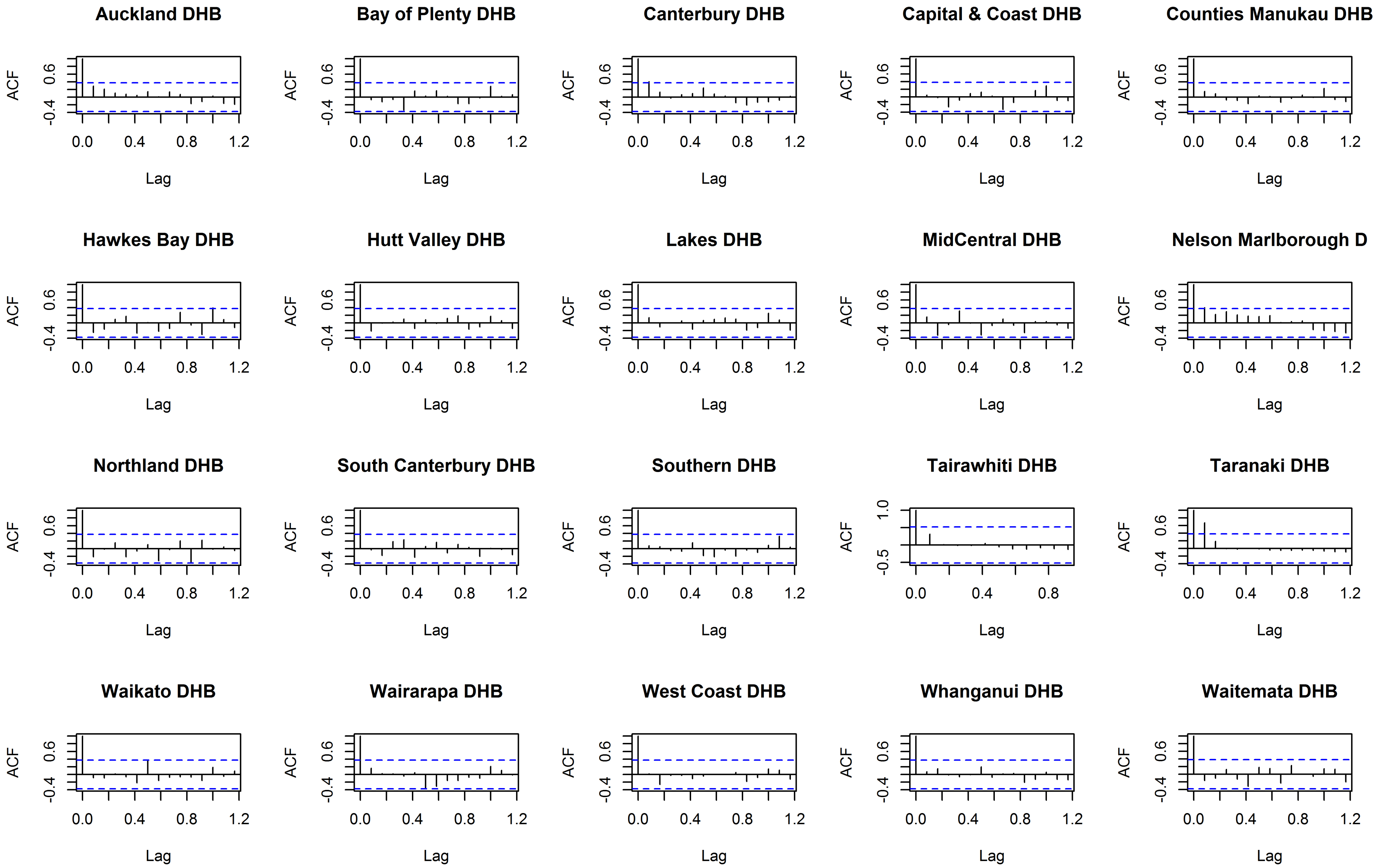


Figure 22: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Allied Health Labour Cost Residuals

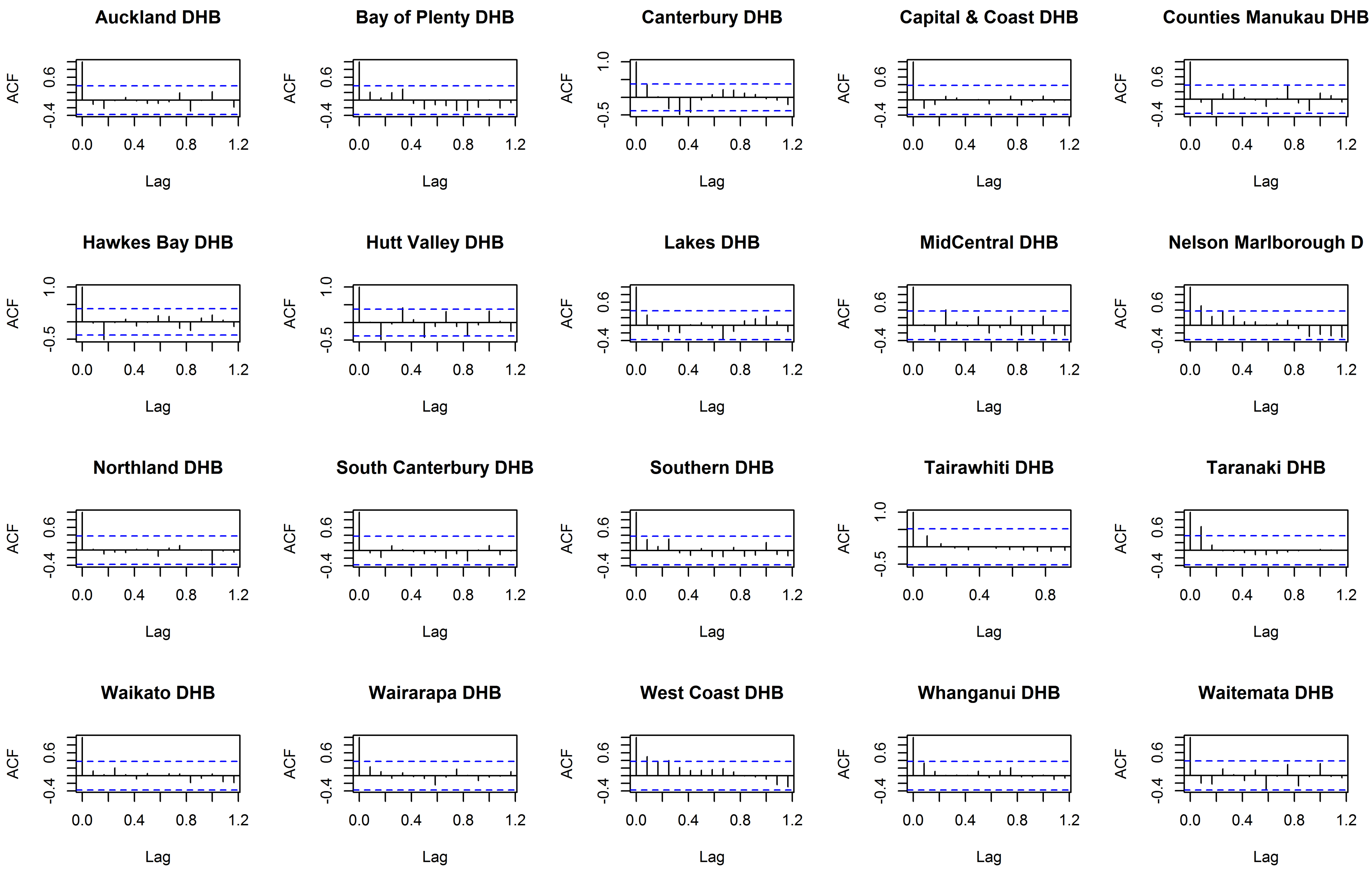


Figure 23: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Support Labour Cost Residuals

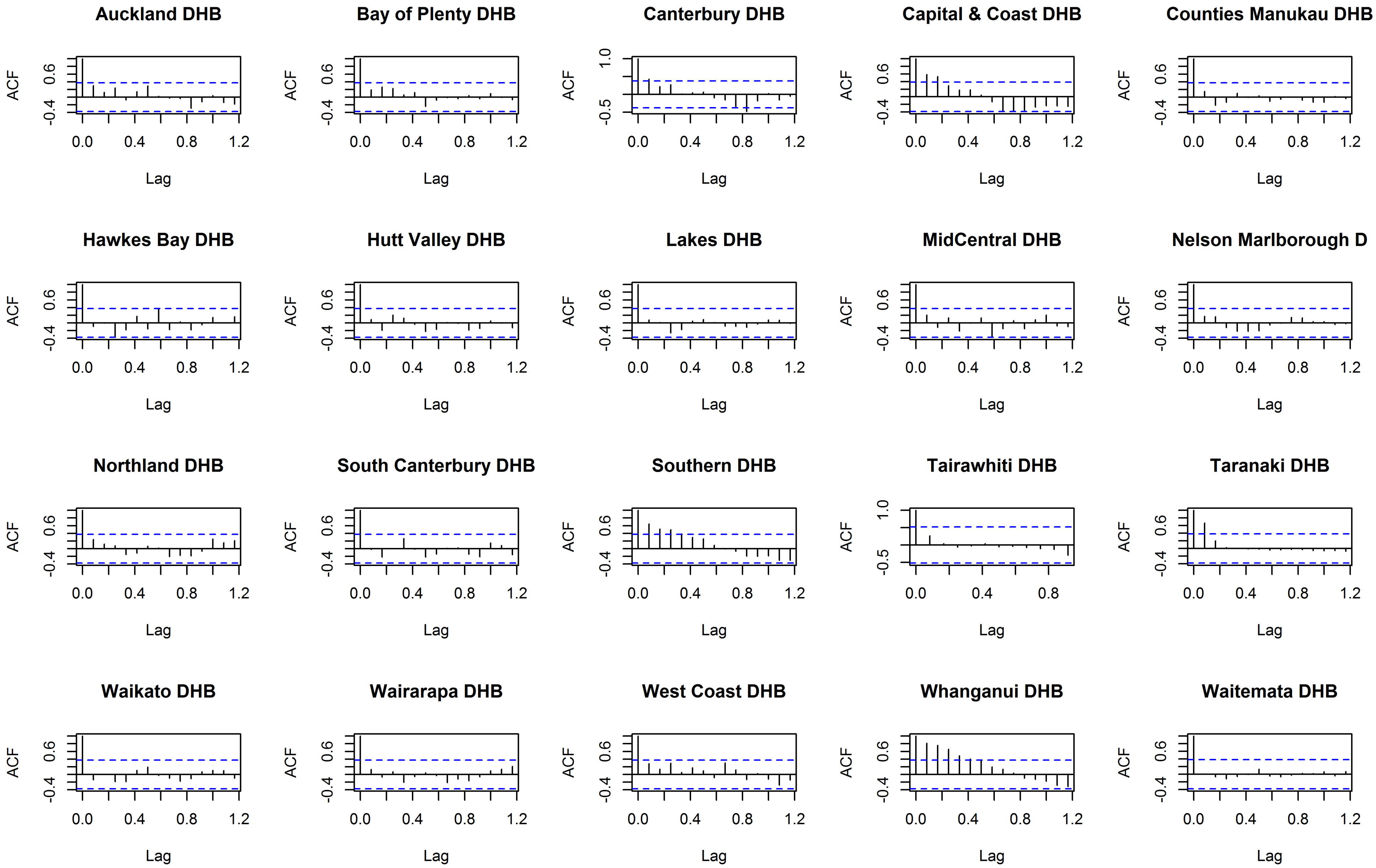


Figure 24: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Management/Admin Labour Cost Residuals

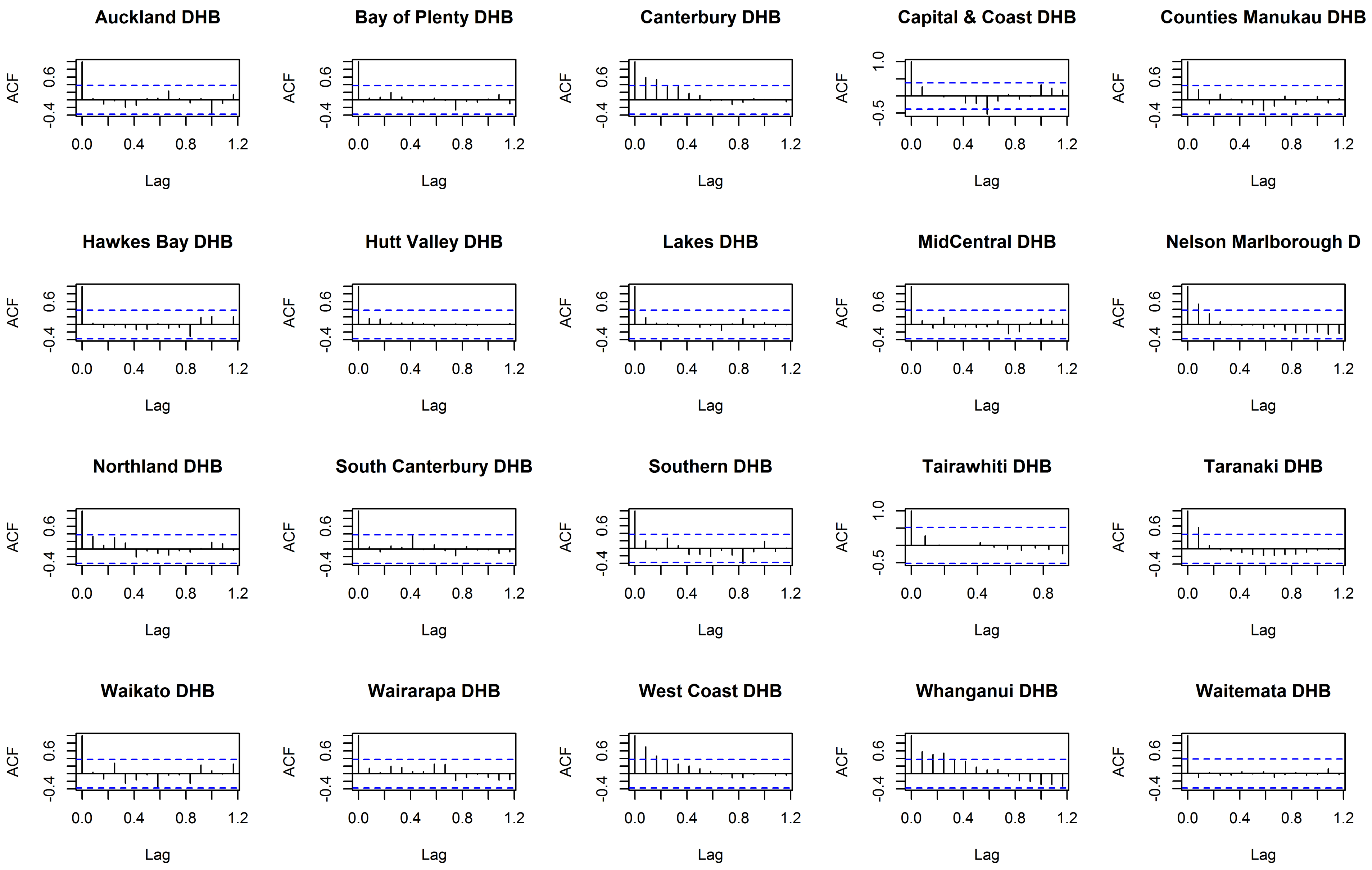
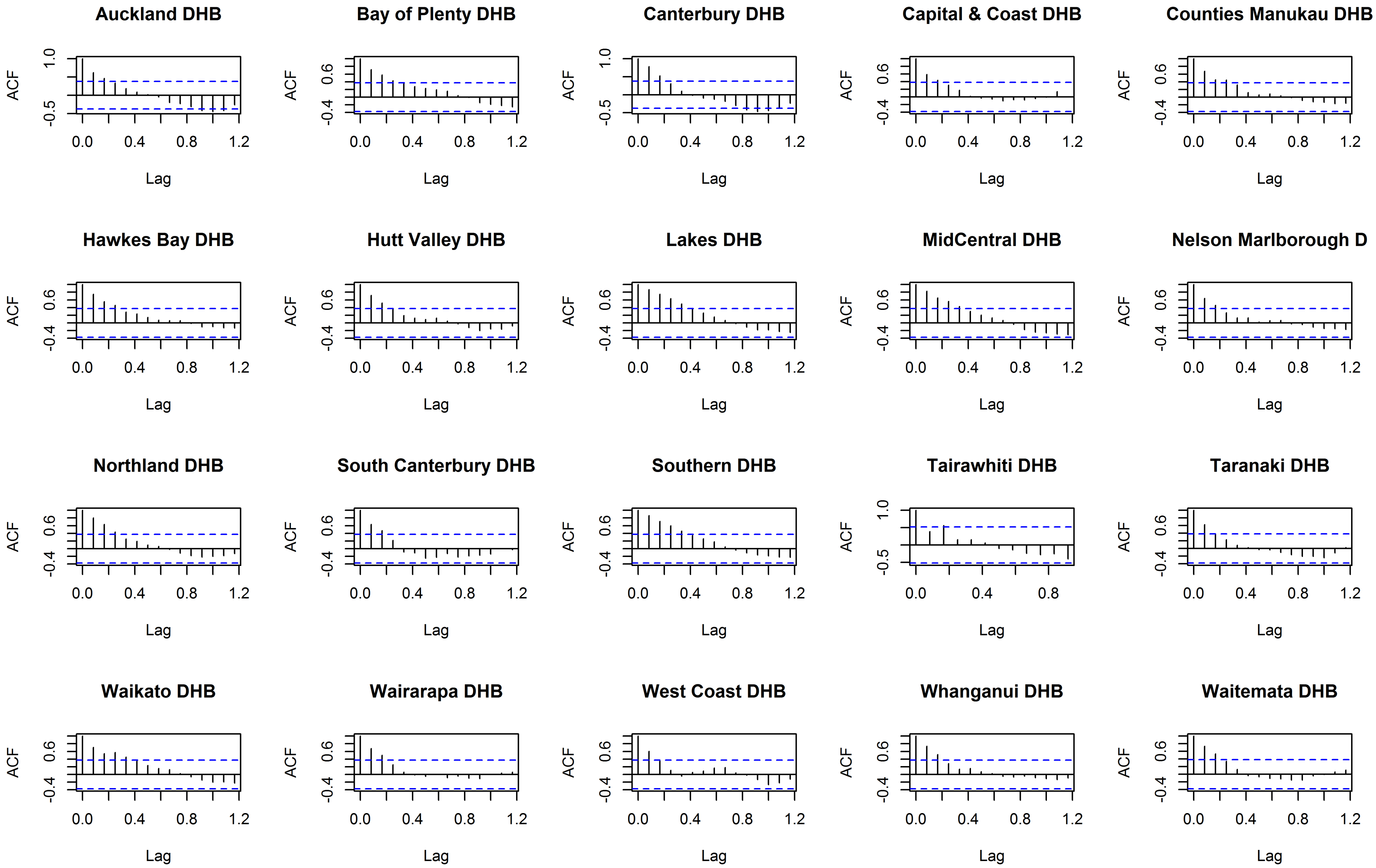


Figure 25: Cobb-Douglas System-of-Equations with Tertiary: Auto-correlation Function of Capital Cost Residuals



8.3.7 Hetroskedasticity in the Model Errors

Figure 26: Cobb-Douglas System-of-Equations with Tertiary: Production Residuals

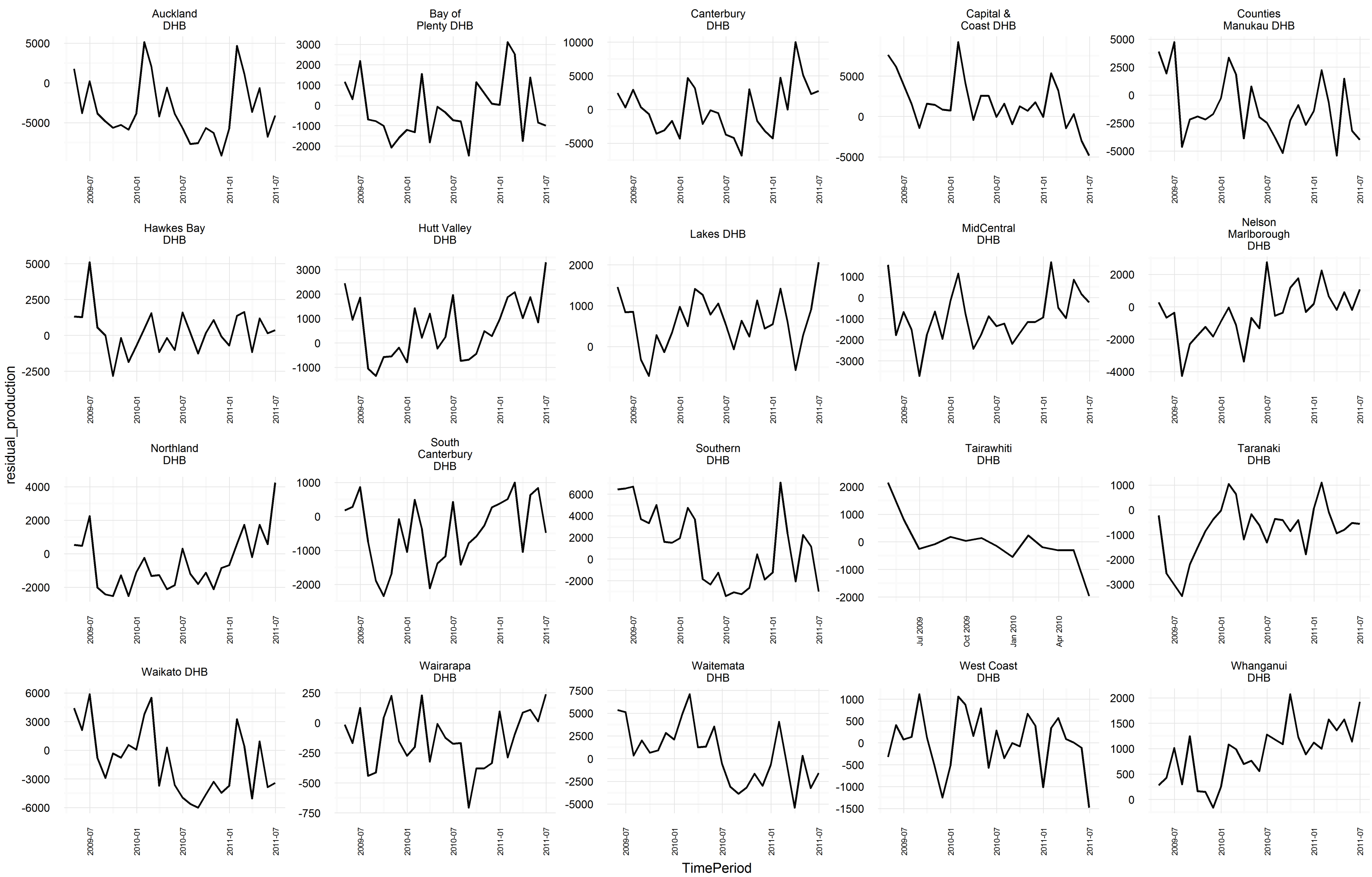


Figure 27: Cobb-Douglas System-of-Equations with Tertiary: Medical Labour Cost Residuals

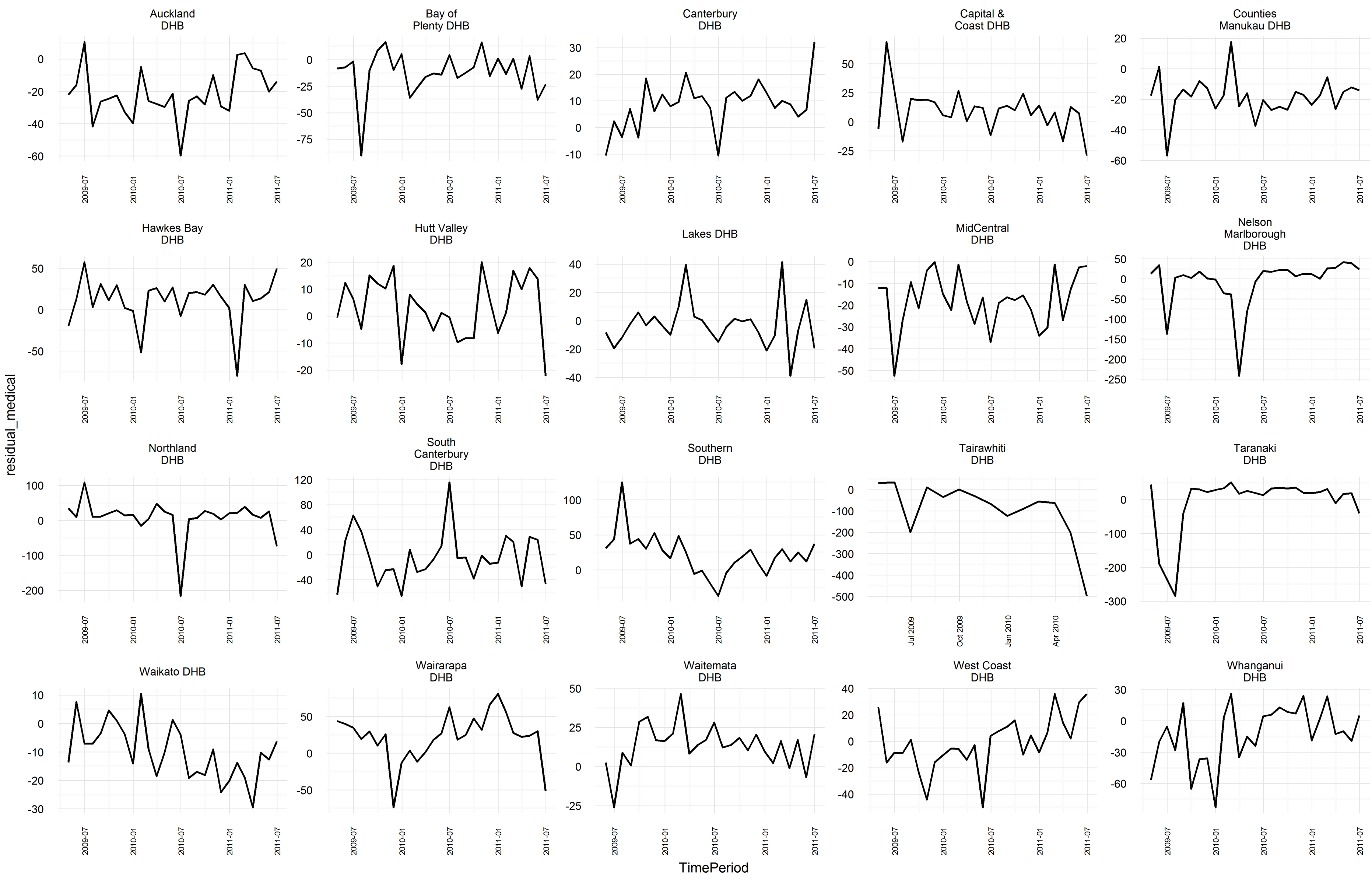


Figure 28: Cobb-Douglas System-of-Equations with Tertiary: Nursing Labour Cost Residuals

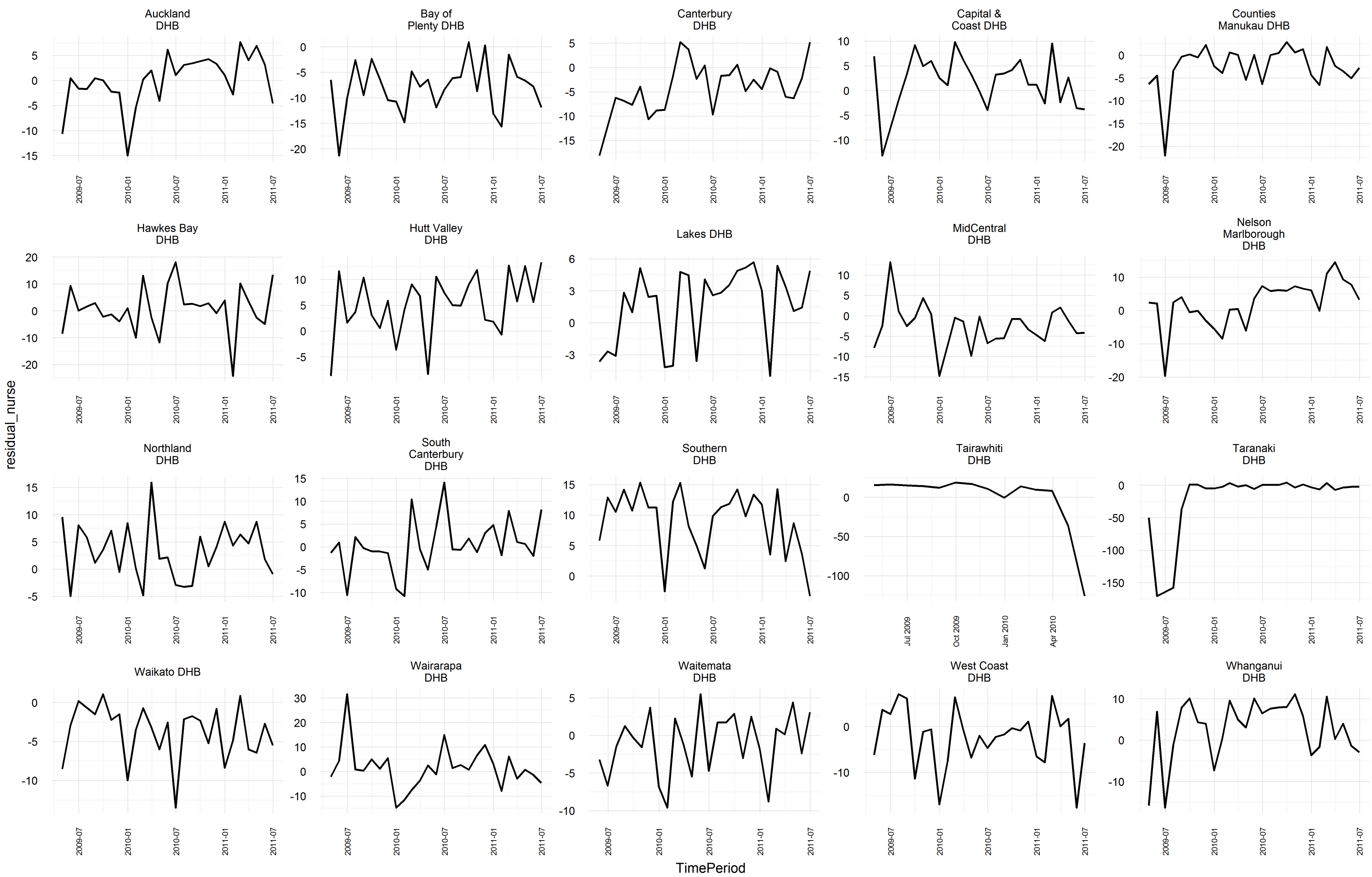


Figure 29: Cobb-Douglas System-of-Equations with Tertiary: Allied Health Labour Cost Residuals

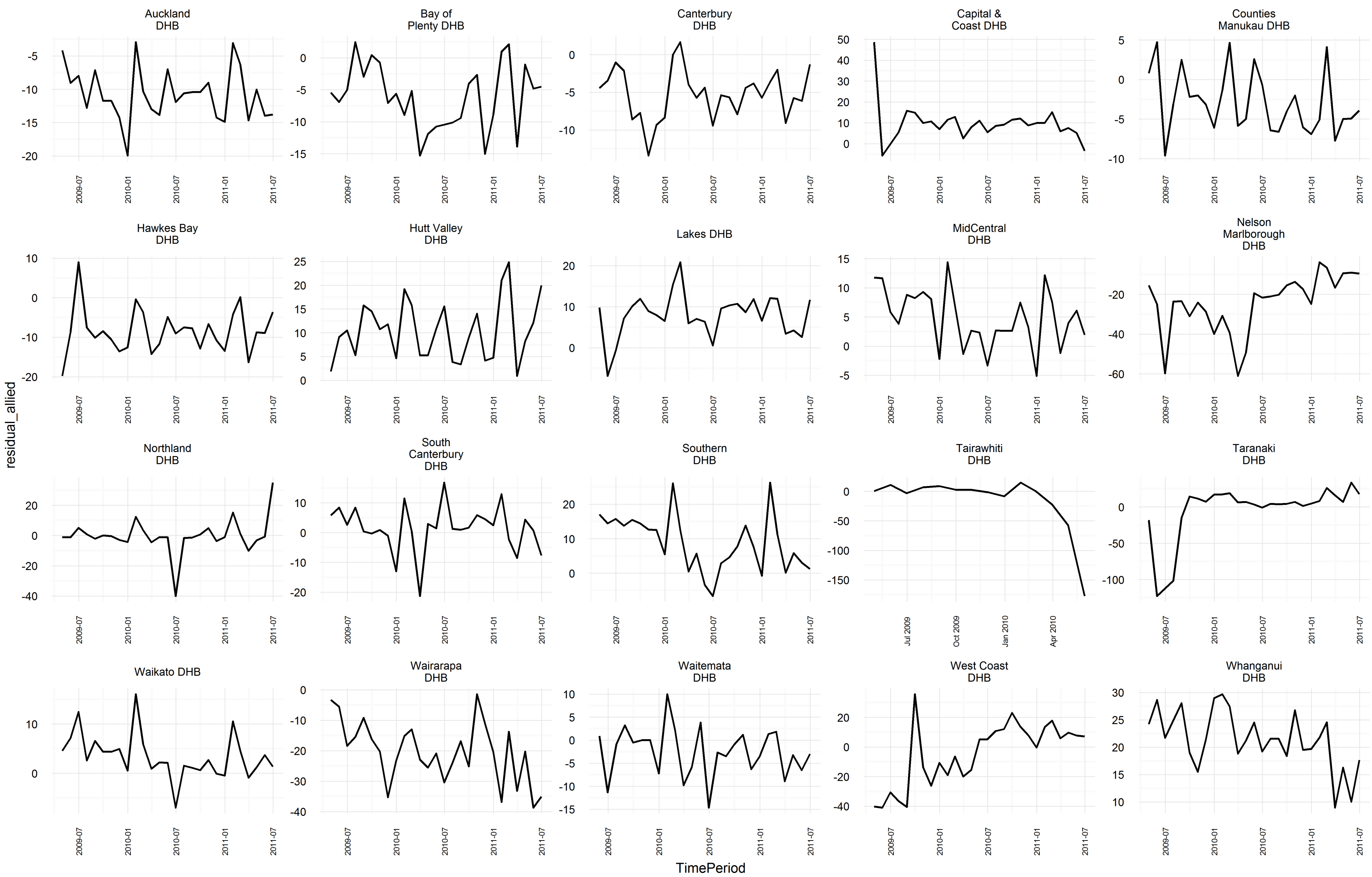


Figure 30: Cobb-Douglas System-of-Equations with Tertiary: Support Labour Cost Residuals

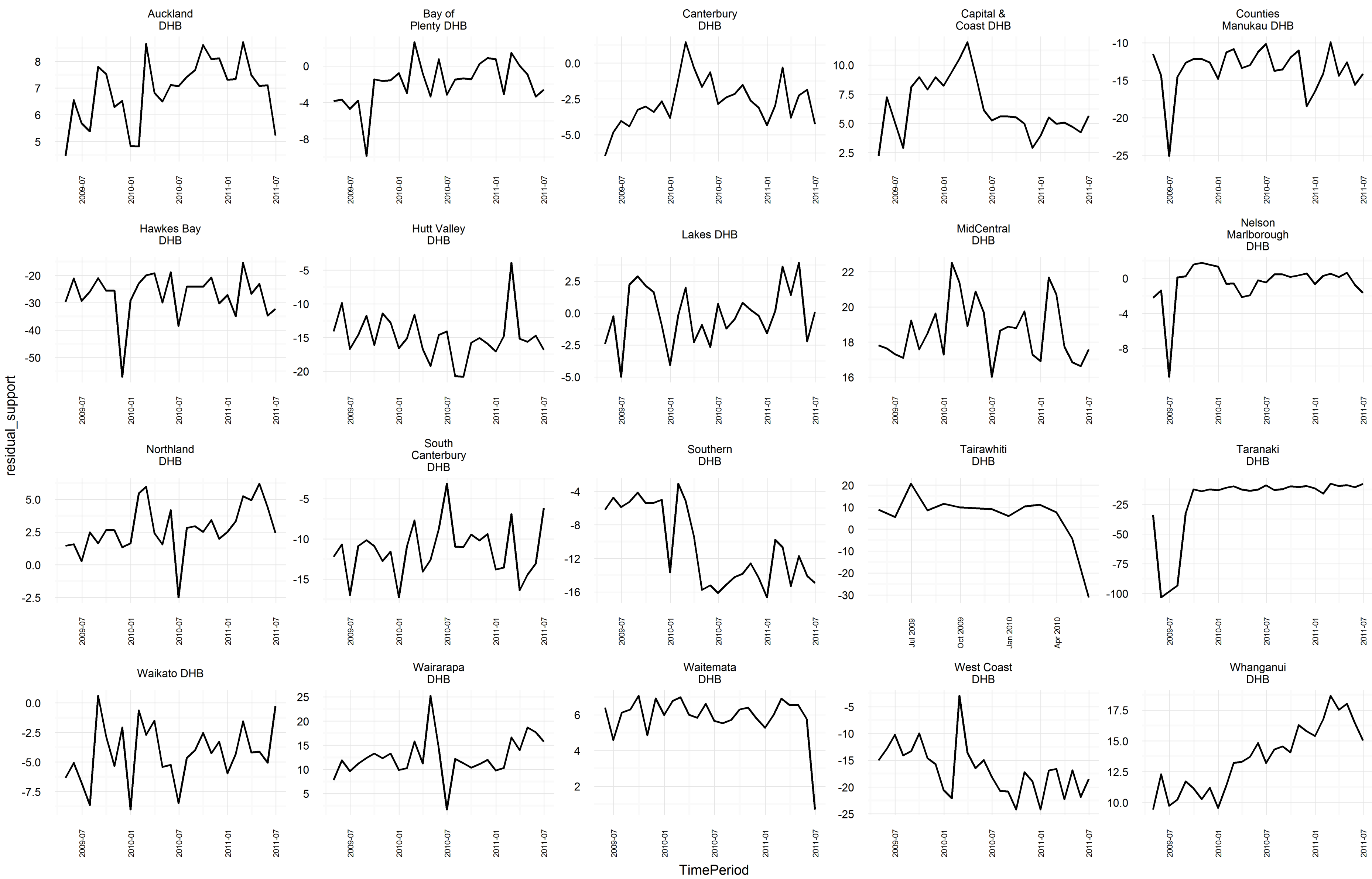


Figure 31: Cobb-Douglas System-of-Equations with Tertiary: Management/Admin Labour Cost Residuals

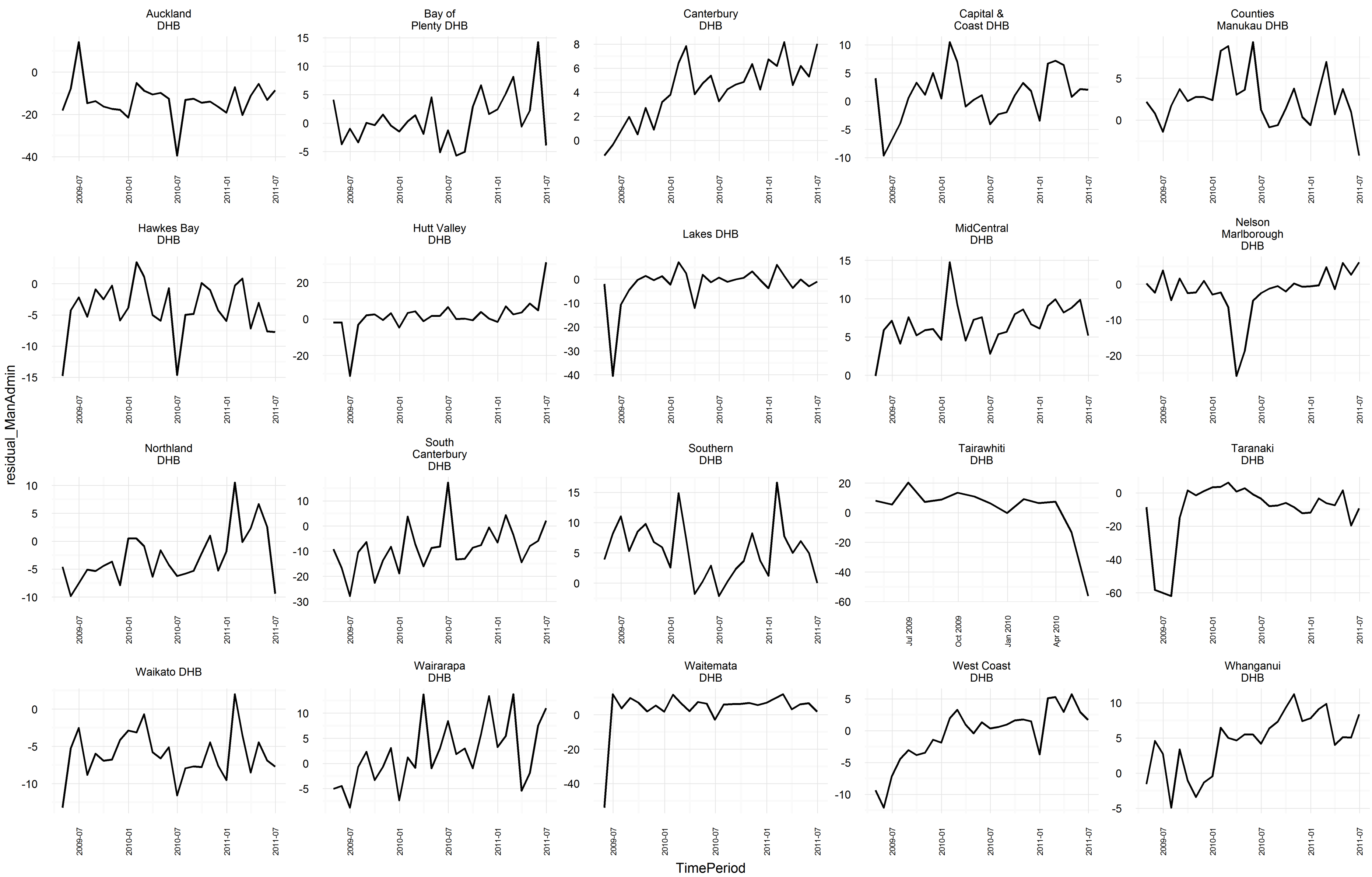
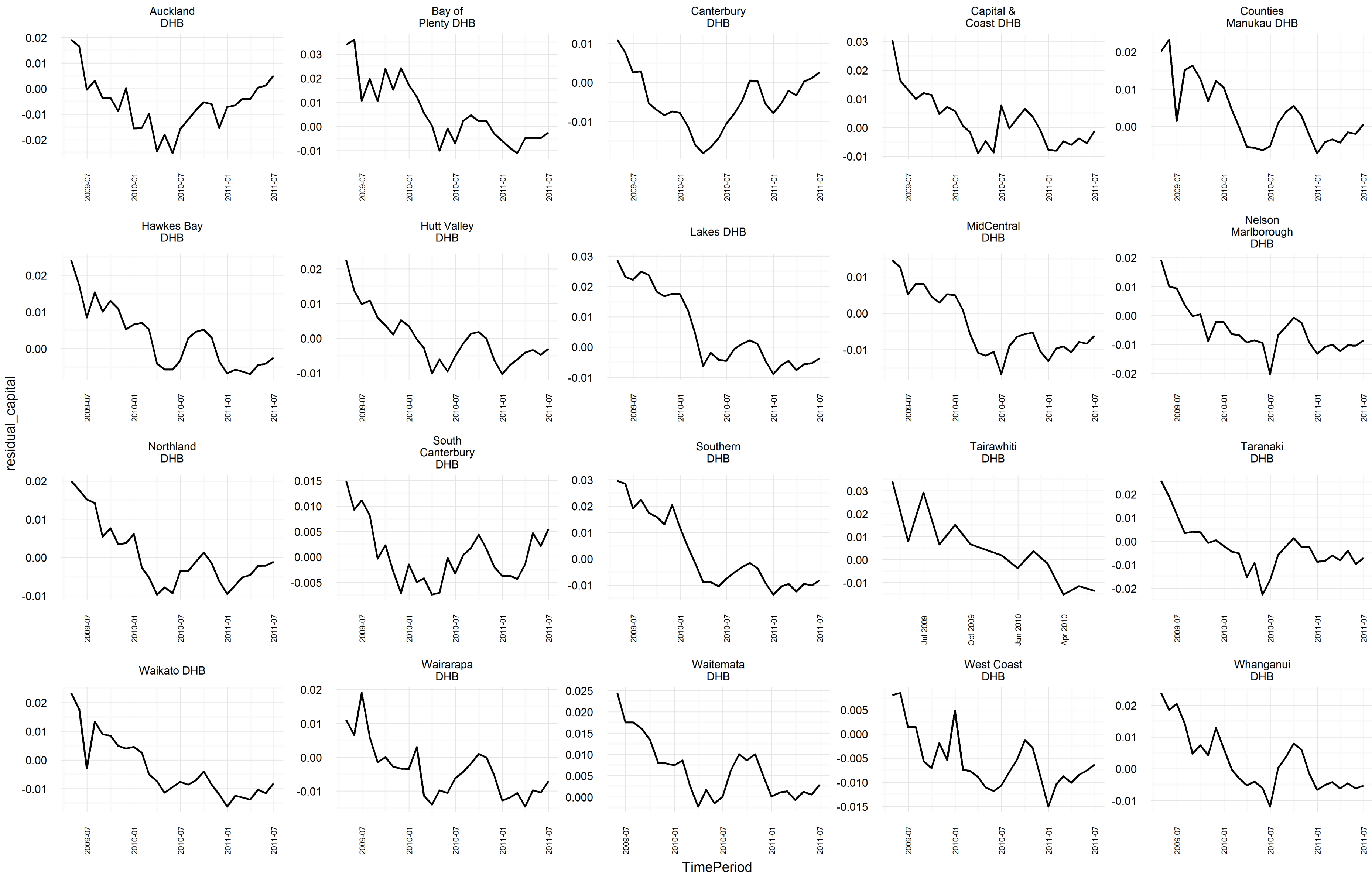


Figure 32: Cobb-Douglas System-of-Equations with Tertiary: Capital Cost Residuals



8.4 Cobb-Douglas System-of-Equations with Tertiary: Graphical Results

Figure 33: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Output

Figure 34: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Medical Labour Costs

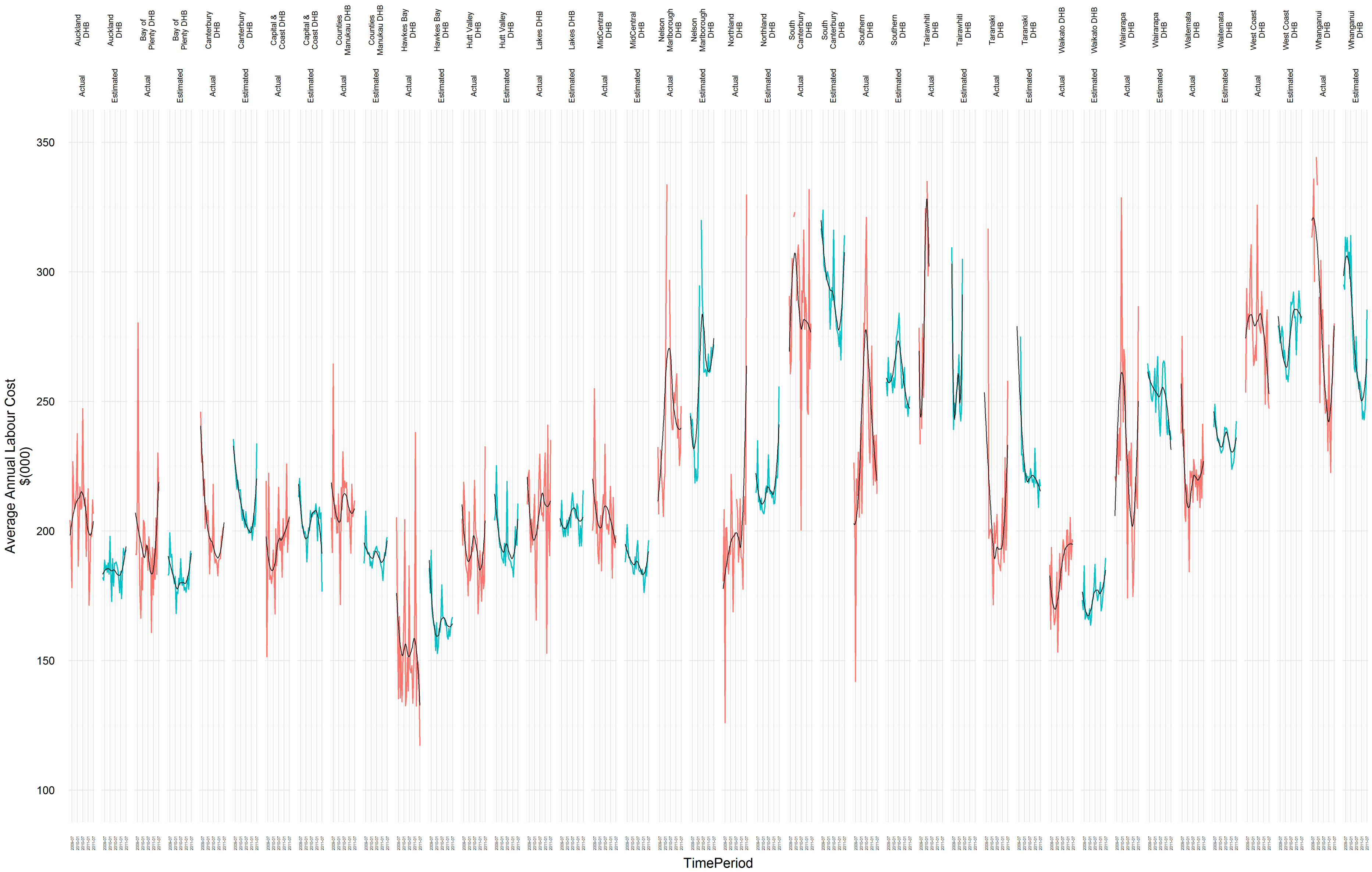


Figure 35: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Nursing Labour Costs

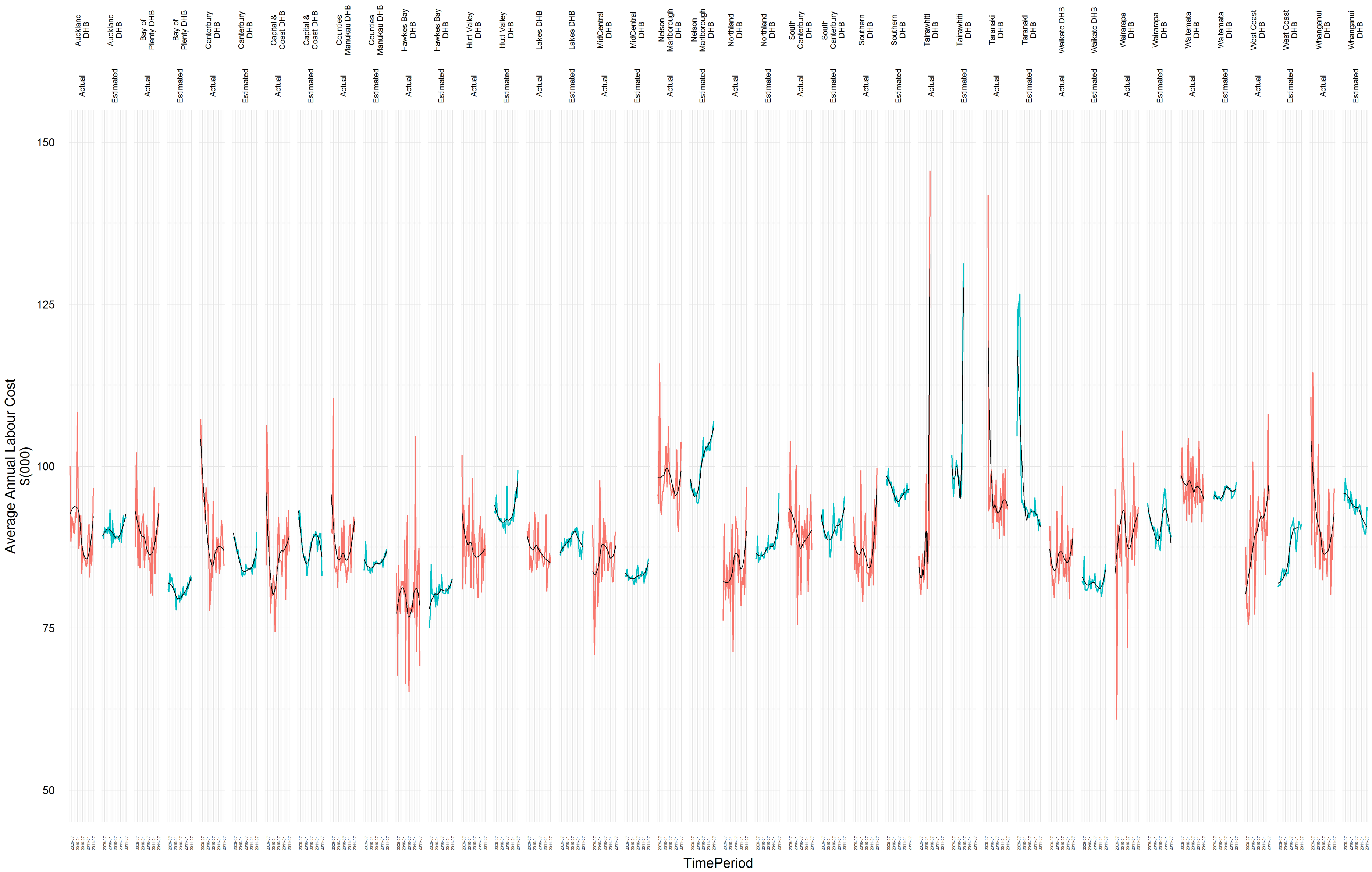


Figure 36: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Allied Health Labour Costs

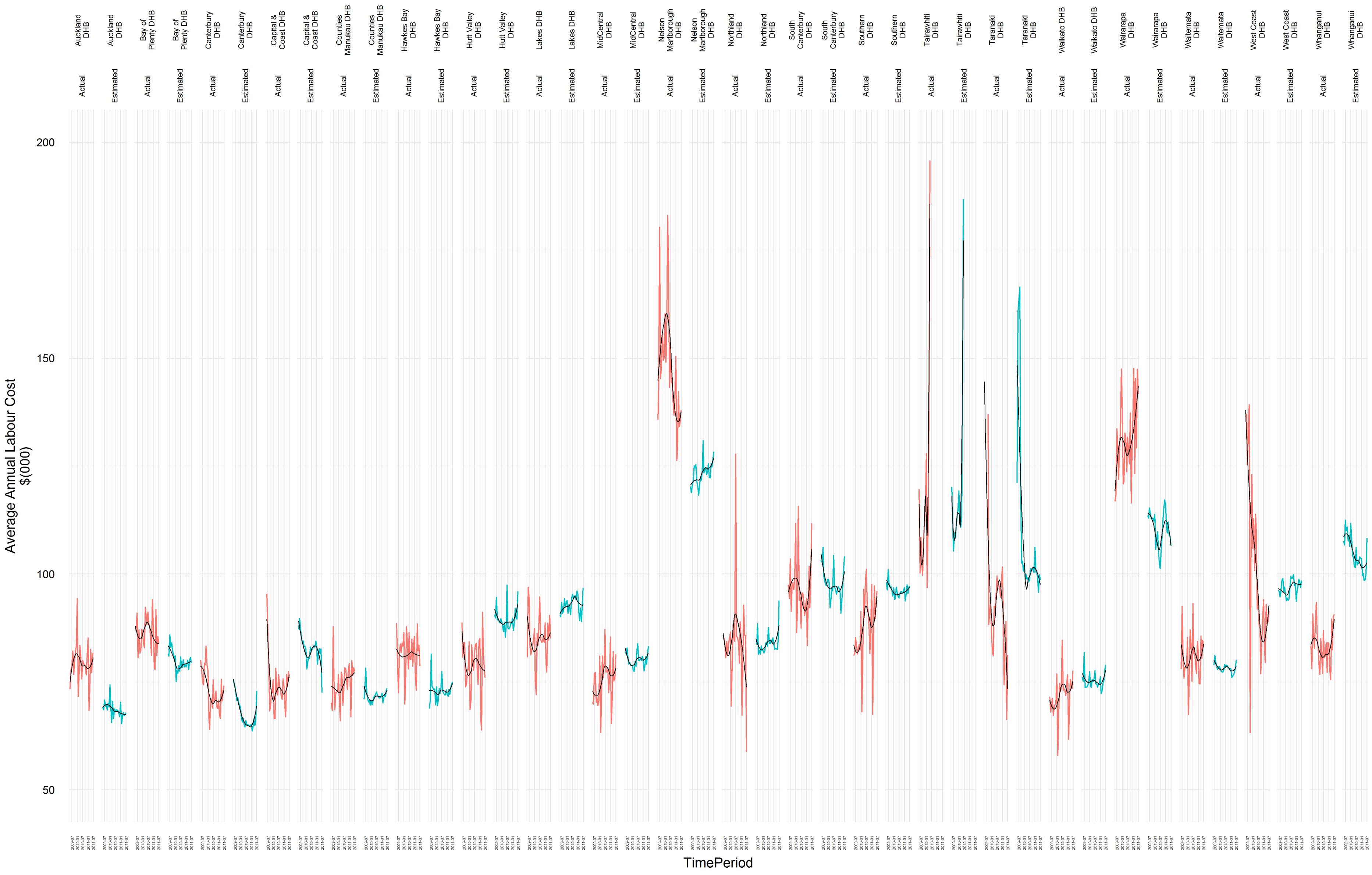


Figure 37: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Support Labour Costs

Figure 38: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Management and Administration Labour Costs

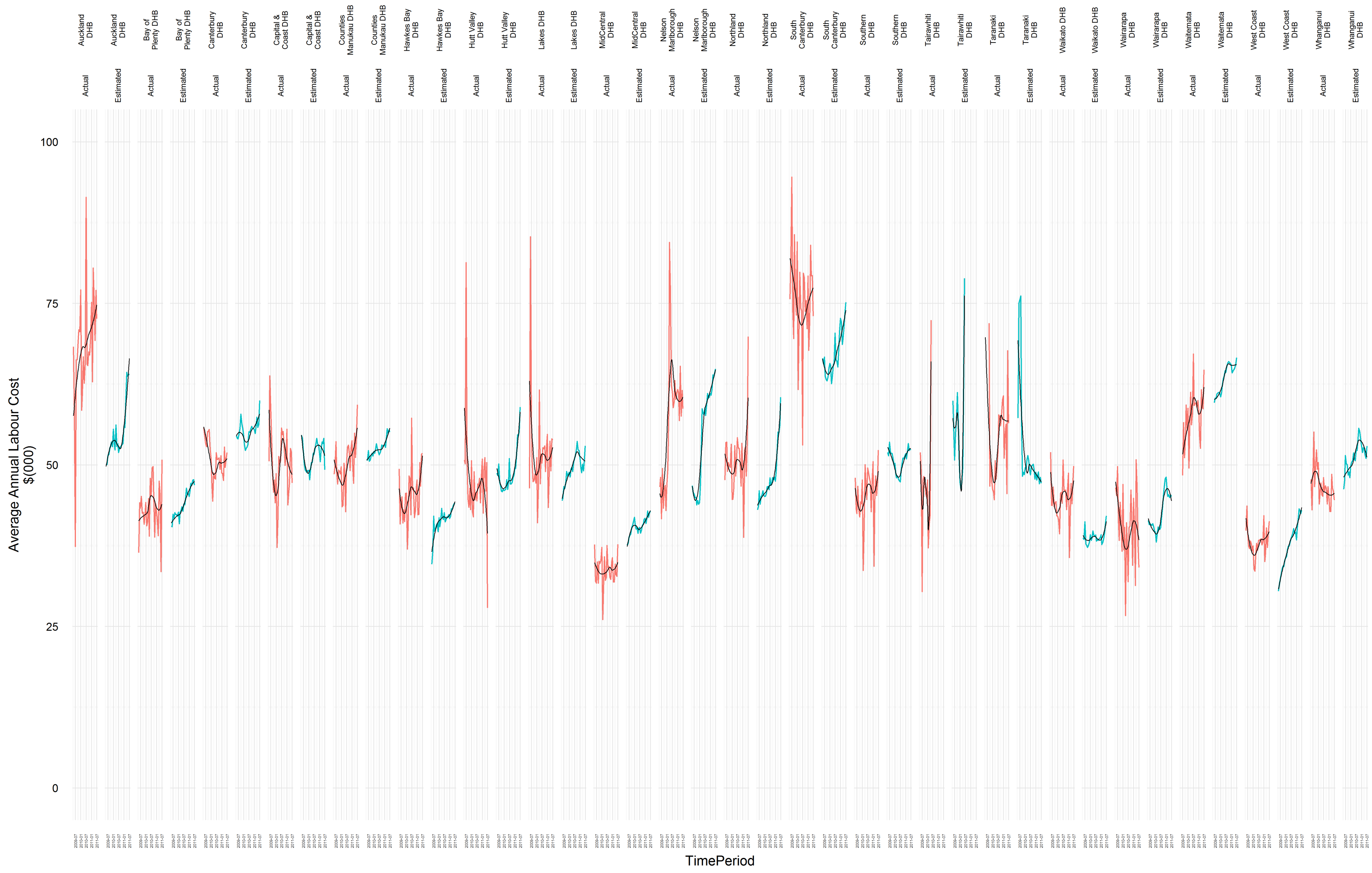
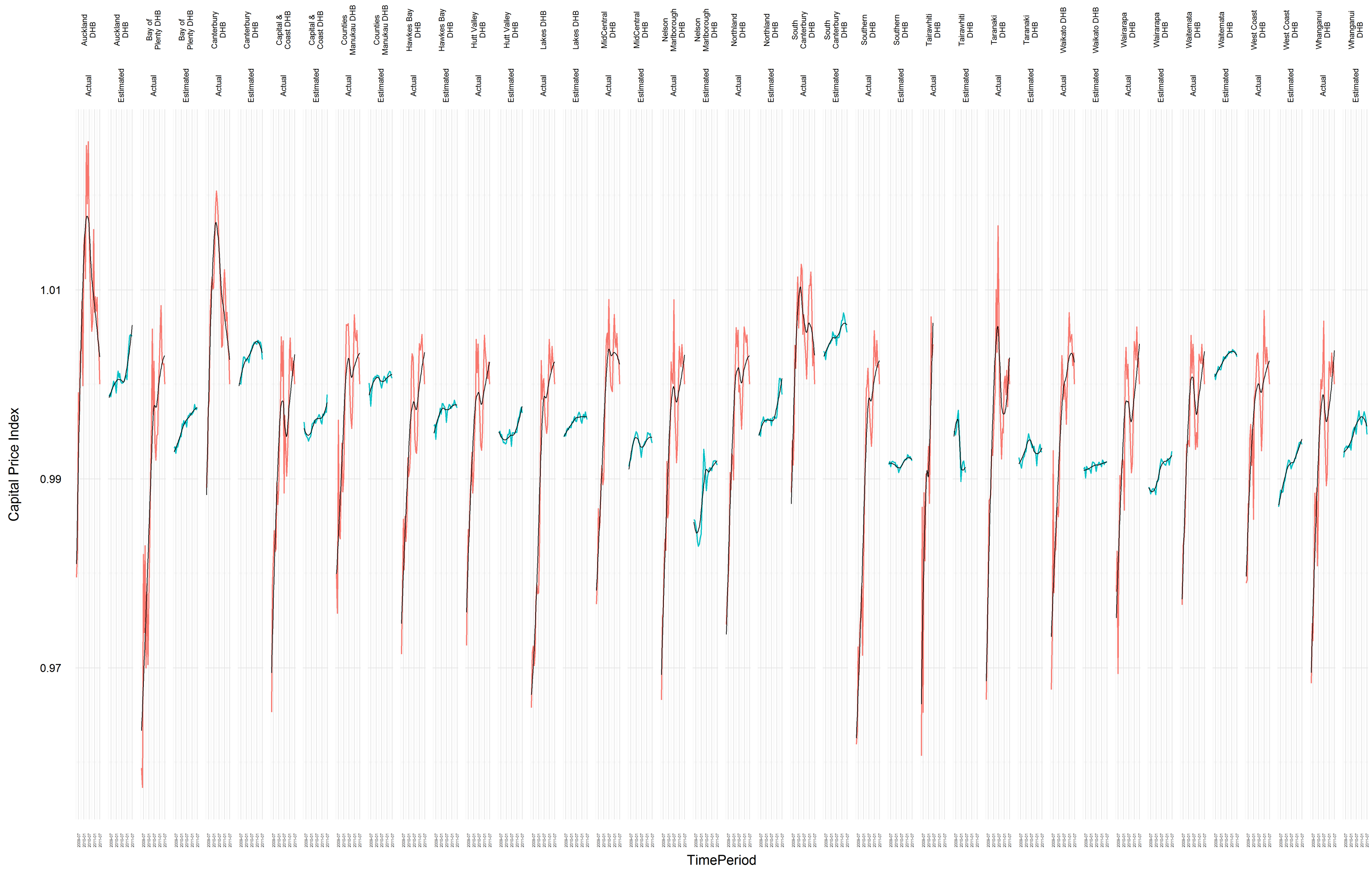


Figure 39: Cobb-Douglas System-of-Equations with Tertiary: Actual / Expected DHB Capital Costs



9 Bibliography

References

[Kaufman(2004)] Bruce E. Kaufman. What unions do: Insights from economic theory. *Journal of Labor Research*, 25(3):351 – 382, 2004.

[Freeman and Medoff(1979)] Richard B. Freeman and James L. Medoff. The two faces of unionism. *NBER Working Paper No. 364*, (364), June 1979. URL `http://www.nber.org/papers/w0364`.

[Paul O'Neil and Minogue(2008)] Tricia Cutforth Paul O'Neil, Jane Bryson and Gill Minogue. *Mental health services in Northland*. Victoria University, February 2008. URL `https://www.victoria.ac.nz/som/researchprojects/dhc-publtns/Mental`$_{h}ealth_{S}ervices_{0}8.pdf$.

[of Health(2005)] Ministry of Health. *Measuring staff resourcesCounting "FTEs.* Ministry of Health, 2005. URL `http://www.nsfl.health.govt.nz/apps/nsfl.nsf/pagesmh/200/`$File/Measuring + staff + resources + Counting + FTEs.doc$.

[Bairam(1994)] Erkin Bairam. *Homogeneous and Nonhomogeneous Production Functions: Theory and Application*. Avebury Ashgate Publishing Ltd, 1994.

[Klump et al.(2012)Klump, McAdam, and Willman] R. Klump, P. McAdam, and A. Willman. The normalized CES production function: Theory and empirics. *Journal of Economic Surveys*, 26(5):769 – 799, 2012. doi: 10.1111/j.1467-6419.2012.00730.x.

[Hsing(1996)] Yu Hsing. An empirical estimation of regional production functions for the us manufacturing industry. *The Annals of Regional Science*, 30(4):351 – 358, 1996.

[Grimes(1991)] Arthur Grimes. A new production function? bowled by a googly. *Applied Economics*, 23(7):1245, 1991.

[Hsing(1993)] Yu Hsing. One the choice of production functions: the case of us manufacturing industries. *Applied Economics*, 25:321–324, 1993.

[Henningsen and Henningsen(2011)] Arne Henningsen and Geraldine Henningsen. Econometric estimation of the "constant elasticity of substitution" function in R: Package micEconCES.

http://cran.r-project.org/web/packages/micEconCES/vignettes/CES.pdf, 2011. URL `http://cran.r-project.org/web/packages/micEconCES/vignettes/CES.pdf`.

[of Statistics(2006)] Statistics New Zealand / Australian Bureau of Statistics. *Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006*. Australian Bureau of Statistics / Statistics New Zealand, 2006.

[Thornton(2010)] Grant Thornton. *Aged Residential Care Service Review*. District Health Boards, New Zealand Aged Care Association, 2010. URL `http://nzaca.org.nz/publication/documents/ARSCR.pdf`.

[Zealand(2011)] Health Workforce New Zealand. As assessment of the utility of graduate entry medical education programmes for new zealand. 2011. URL

A Background to the New Zealand Health Sector

A.1 Health-sector Industries

Statistics New Zealand's (SNZ) Business Demographics information provides an overview of the sub-industries comprising the health-sector, and how they have changed over time. Using the Australia New Zealand Standard Industry Classification (ANZSIC), the "health-sector" is 16 ANZSIC industries whose employee count and number of providers are contained in Figure (40) below.

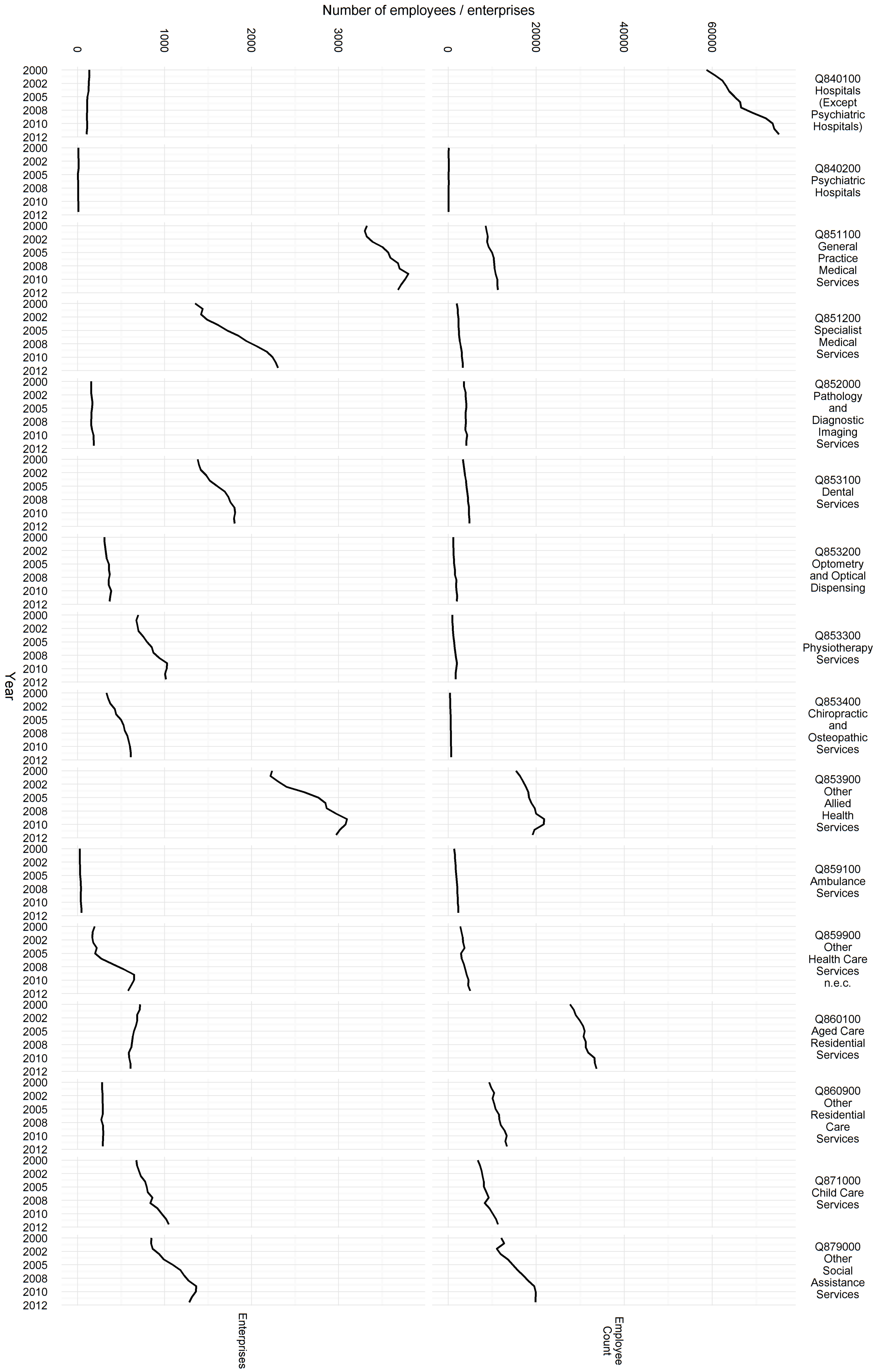


Figure 40: Health Sector Business Demographic Profile

A.1.1 Secondary Care

In 2012, approximately 17,000 enterprises collectively employed around 208,000 people to deliver health care. Thirty six percent of the workforce were employed within ANZSIC Q840100: "Hospitals (except psychiatric Hospitals)", whom are collectively the public and private sector "Secondary Care" providers. Government-owned DHBs employed the majority of ANZSIC Q840100's workforce. Between them, DHBs employ 72,000 of the 75,000 secondary care workforce.

The remaining smaller workforce within the Hospitals industry, represented private sector secondary care providers. Private sector secondary care providers work together with ANZSIC Q851200 (Specialist Medical Services) to provide private secondary health care in normally an outsourcing health-service delivery model. Specialists from Q851200 contract with private secondary care providers for the use of surgical space and post-operative care. Consequently, the majority of the private secondary care workforce comprise nurses and administration staff.

A.1.2 Disability Support Services

The "Disability Support Services" (DSS) sector are ANZSIC industries Q860100 (Aged Residential Care), Q860900 (Other Residential Care) and Q879000 (Other Social Assistance Services). DSS employed 67,000 people or approximately a third of the health-sector's workforce in 2012. Aged Residential Care was the second largest employer within the entire health-sector, and comprised predominately private sector providers. ANZSIC Q860900 are residential care providers for intellectual disability or physical disability care. ANZSIC Q879000 provides a wide variety of community-related social support service care including adult day care centre operation; disability assistance; and youth and welfare counselling with the other sub-industries within DSS sector its major customer.

A.1.3 Allied Health

The Allied Health industries are defined by ANZSIC sub-industries Q853100 - Q853900. Allied Health providers are predominately private providers who deliver specialist health-services of a specific nature. Unlike "general" practitioners, Allied Health providers specialise in specific illness or treatment types; for example, dentistry, or optometry which involve dental and eye health care respectively. Collectively in 2012, the Allied Health industries employed 28,000 people, or approximately 14% of the health-sector's workforce, and were almost exclusively privately owned.

A.1.4 General Practice

ANZSIC Q851100, General Practice Medical Services, are health providers who deliver "primary care": they are normally the first point of patient contact with the health-sector. While multiply "entry points" into the health system exist; for example, through the ambulance services provided by Q859100, or through the emergency departments of DHBs in Q840100, General Practitioners are where most persons choose to initially engage with a health professional. Collectively, General Practice employs approximately 11,000 persons, or 5% of the health-sector's workforce. With the exclusion of a small number of practices on the West Coast of the South Island, almost all General Practices are exclusive privately owned.

ANZSIC Q852000, Pathology and Diagnostic Imaging Services, are the laboratory, pathology and specialist imaging industries (Diagnostic Health) who provide diagnostic and laboratory services to the health-sector. Both DHBs and the private sector own enterprises within this industry.

A.2 Economic Performance

A.2.1 Contribution to Gross Domestic Product

Constituting approximately 6.8% of New Zealand's current price Gross Domestic Production (GDP) for the year ending March 2010 the health-sector was New Zealand's third largest industry, contributing approximately $12.0 billion value added to New Zealand economy, and similar in size to the Real Estate industry.

Between 2000 - 2010, constant price health-sector GDP grew at an average annual 4.05% rate of growth each year, well in excess of the 2.54% growth rates experienced within the rest of the economy. The first decade of the new millennium represented the sector's "boom years" and were the culmination of two decade periods of accelerating economic growth (Figures 42 and ??).

The sector's recent economic growth is in stark contrast to its boom years. SNZ's data shows virtually no increase in health-sector constant price GDP has occurred since 2010, despite strong economic growth occurring elsewhere within the New Zealand economy. health-sector economic output increase on average 0.1% per year between 2010 - 2013, despite the remainder of the economy expanding at an annual average 2.29% rate of growth for the same period.

SNZ's constant price value added series in Figure ?? illustrates a sudden halt to the health-sector's economic growth between 2010 - 2013. While SNZ's current price gross output series is yet to be updated and published to reflect the years 2011 onwards, the Treasury's Fiscal Time Series data is available for the 2010 - 2013 period.[70] Central Government health expenditure increased from $13.1 billion in 2010 up to $14.5 billion in 2013, or an annual average 3.4% increase in funding over the 2010 - 2013 period.

In order for overall average health-sector GDP to increase by 0.1% over the 2010 - 2013 period when the publicly funded health care component increased 3.4% over the same time means privately-funded health purchasing very suddenly and very dramatically reversed from its 7.9% annual average decade rate of funding increase over 2000 - 2010 to approximately a 3.5% *rate of funding decline* on average every year between the 2010 and 2013 years.

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## Error in if (.allows_extensions(db)) {: missing value where TRUE/FALSE
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## Error in if (.allows_extensions(db)) {: missing value where TRUE/FALSE
needed
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"Measure")): object 'Graph_Me_2000' not found
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[70]Discussed in section A.2.2 below

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needed
```

Method	Gamma	Delta	Rho	Nu	Elasticity
BFGS	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Conjugate Gradients	4.455	0.398	0.298	1.015	0.77
95% CI	3.518 - 5.392	0.174 - 0.622	-0.245 - 0.841	0.994 - 1.036	
Kmenta	8.01	0.119	-1.312	0.968	
95% CI	5.65 - 10.369	-0.206 - 0.443	-6.216 - 3.591	0.952 - 0.985	
L-BFGS-B	9.827	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Levenberg-Marquardt	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Nelder-Mead	8.873	0.136	-0.511	0.962	2.046
95% CI	7.369 - 10.377	0.02 - 0.252	-1.064 - 0.041	0.943 - 0.981	
Newton	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
PORT	9.828	0.139	-0.482	0.95	1.931
95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Simulated Annealing	5.01	0.473	0.536	0.997	0.651
95% CI	3.941 - 6.079	0.23 - 0.716	-0.039 - 1.111	0.976 - 1.017	

Table 10: Two Factor Constant Elasticity of Substitution Production Function - Multiple Optimisation Methods

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: object 'Results' not found

## Error in paste0(round((((Results$Year_2012/Results$Year_2010)^(1/2)) - :
object 'Results' not found

## Error in eval(expr, envir, enclos): object 'Results' not found
```

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95% CI	8.173 - 11.482	0.019 - 0.259	-1.043 - 0.079	0.931 - 0.969	
Simulated Annealing	5.01	0.473	0.536	0.997	0.651
95% CI	3.941 - 6.079	0.23 - 0.716	-0.039 - 1.111	0.976 - 1.017	

Table 11: Two Factor Constant Elasticity of Substitution Production Function - Multiple Optimisation Methods

Tables (**??**) and (**??**) are the SNZ Business Demographic workforce headcount and enterprise count from Figure (40). As see graphically in Figure (40) and numerically in Tables (**??**) and (**??**), most of the 3.5% rate of private sector funding decline effected the Allied Health, General Practice and the Diagnostic health-service industries.

During the decade of the health-sector's boom years, the General Practice workforce grew an average 2.75% each year. Since 2010, its rate of workforce growth has fallen to 0.6%, or under a quarter of its previous decade average. General Practice enterprise numbers, having previously increased by 1.25% on average each year over the boom years, have now reversed and have declined an average 1.1% each year since 2010.

The Allied Health workforce during the boom years experienced average annual rates of growth of 3.8% each year between 2000 - 2010. Since 2010, the industry's workforce has declined 4.2% on average every year. While the number of Allied Health provider enterprises increased 3.4% on average every year between 2000 - 2010, since 2010, their numbers have declined by 1.0% every year.

The majority of the Allied Health industry's decline was experienced in "Q853900 Other Allied health-services" whose health-services include audiology, dental hygiene, dietician services, midwifery and podiatry care.[71] Q853900 experienced an average 6% decline in employment numbers and a 2% decline in providers since 2010. Private sector health spending retrenchment can be seen across the board in other Allied Health industries.

The Diagnostic health-service workforce, expanding on average by 2.0% per year over 2000 - 2010, but shrank an average of 2.6% each year between 2010 - 2012.

A.2.2 Sources of Health Service Funding

The health-sector received approximately $18.5 billion worth of funding in 2010, $13 billion of which was purchased by the New Zealand Treasury on behalf of New Zealanders. The remaining $5.5 billion was purchased by private organisations like private insurers, and directly by the household sector. As a proportion of total Crown Revenue, health funding has increased from approximately 12.8% of total Crown revenue in 1997 up to 17.6% by 2010, its highest proportion over the 1997 - 2013 period.

Achieving "sustainability" in all aspects of health care, including its financial sustainability, has been one of the National-led Government's policy directions since its election in 2008 with a number of policy initiatives undertaken to reduce the rate of health expenditure

[71] [of Statistics(2006)] page 347

growth.[72] As a result, since 2010, the proportion of total Crown Revenue directed towards health expenditure has fallen from its 2010 high of 17.6% to approximately 16.7% in 2013.

[72] http://www.beehive.govt.nz/speech/speech-address-nz-healthcare-summit-2013

Deriving a timeseries for separating out public / private health-sector funding sources is complicated by the Government's change from cash to an accrual accounting basis in 1990, and its move to Generally Accepted Accounting Principles in 1996. Even with these caveats in mind, Figure 43 suggests a significant proportion of the 3.89% increase in constant price health-sector GDP over the 1990 - 2000 period in Figure **??** was derived from increased private sector health-service funding.

While the Central Government funded approximately 71% of the health-sector in 2010, historically it had purchased a significantly higher proportion of the health-sector's output. In 1992, the Central Government funded 76.6% of the health-sector. By the end of the decade, Central Government purchasing declined to approximately 74.0% of health-services as private sector funding sources increased to reflect demand. Private sector health funding increased from 23.4% in 1992 to 26.0% by 2000.

Over the first decade of the new millennium, when constant price health-sector GDP recorded its largest decade annual average rate of growth of 4.05% each year between 2000 - 2010, the proportion of private health care funding increased from 26.0% of total health-sector Gross Output in 2000 to 29.1% of Gross Output by 2010. Publicly-funded health care declined from 74.0% of total Gross Output in 2000 to 70.9% by 2010. Private sector health-service funding increases contributed significantly to the high rate of health-service constant price GDP growth.

Figure 41: Central Government Health Outlays - Health Expenditure and Health as a Proportion of Total Government Revenue

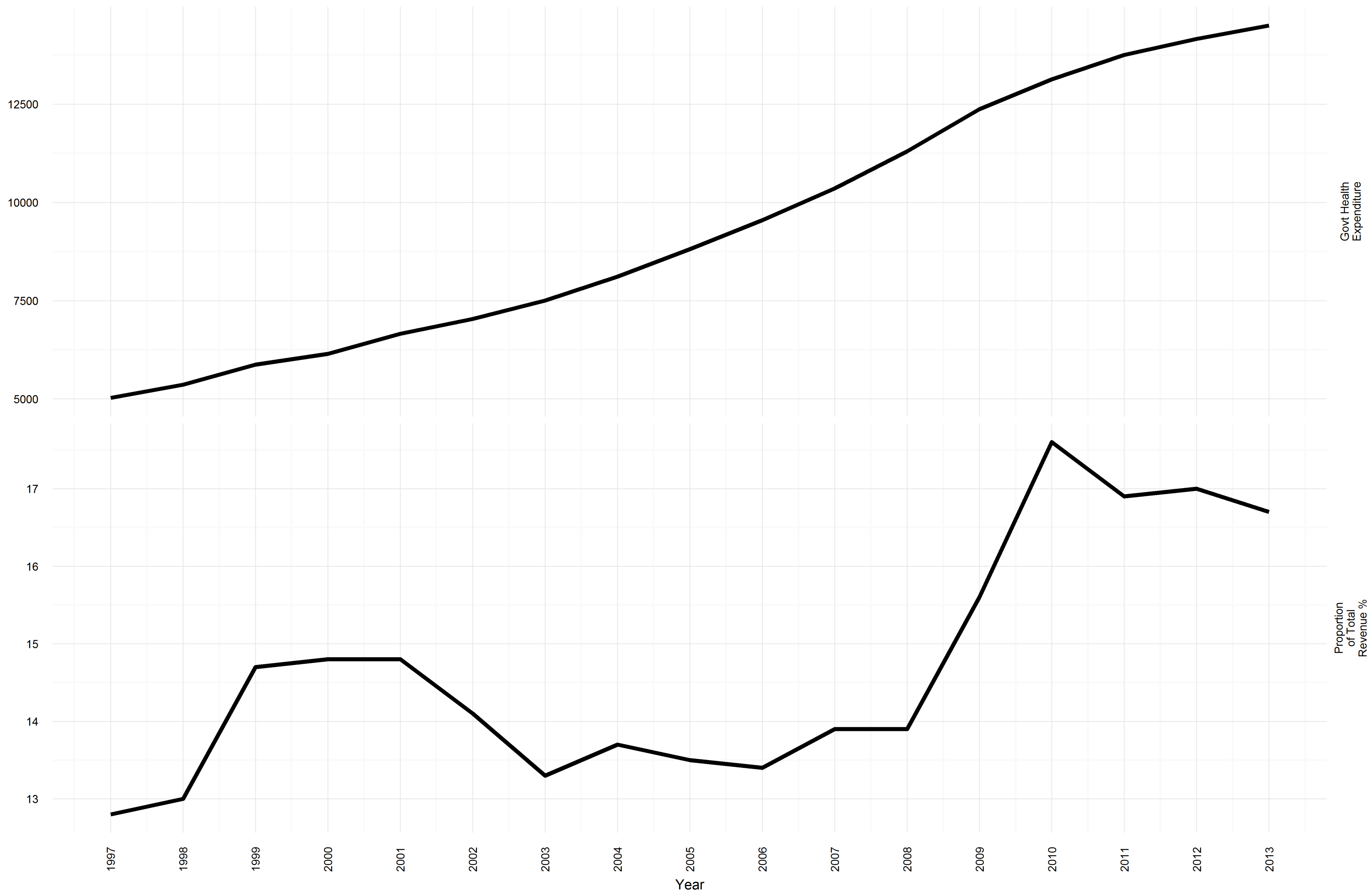


Figure 42: Constant Price Gross Domestic Product - Health Care and Social Assistance Industry

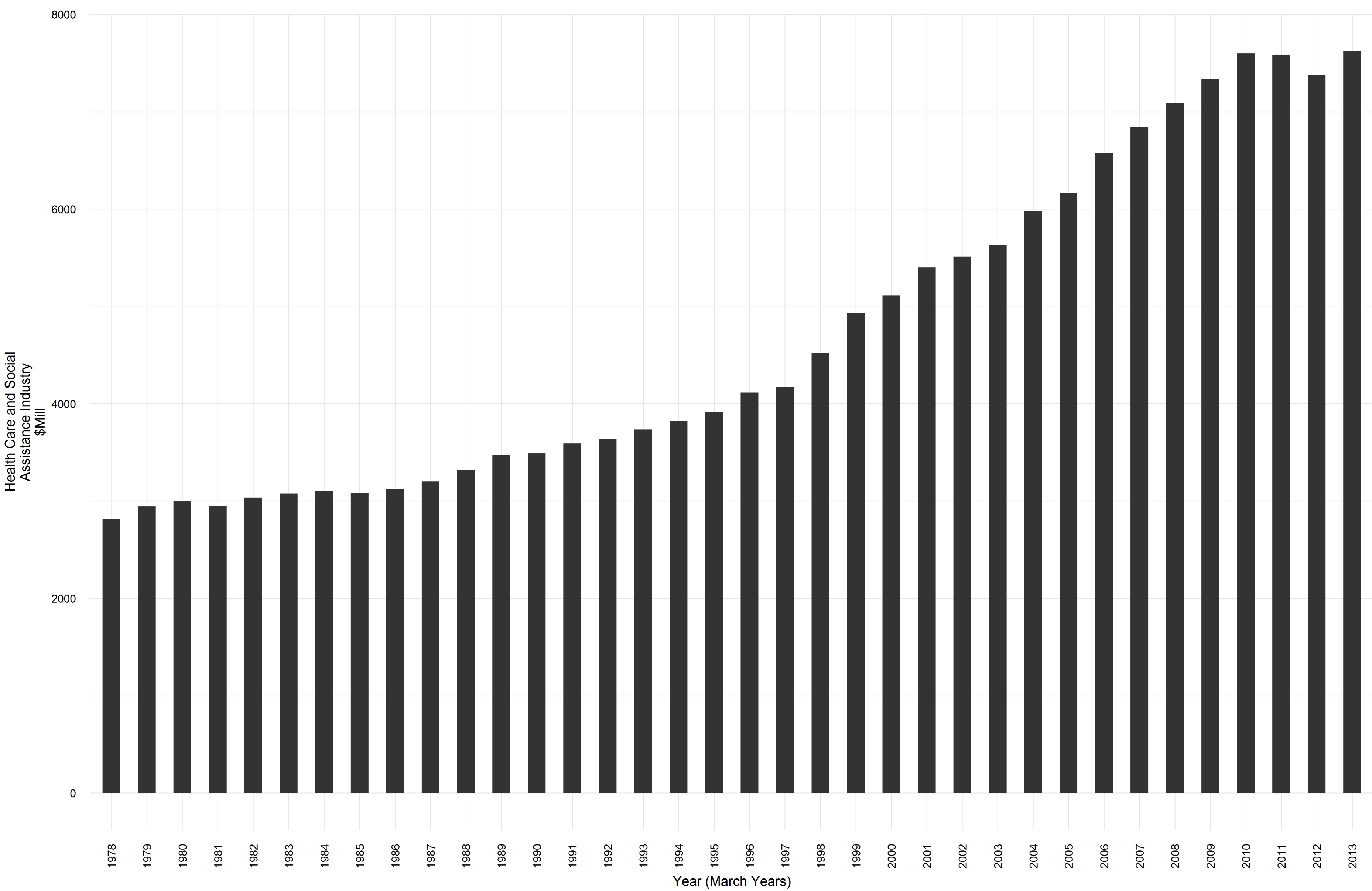
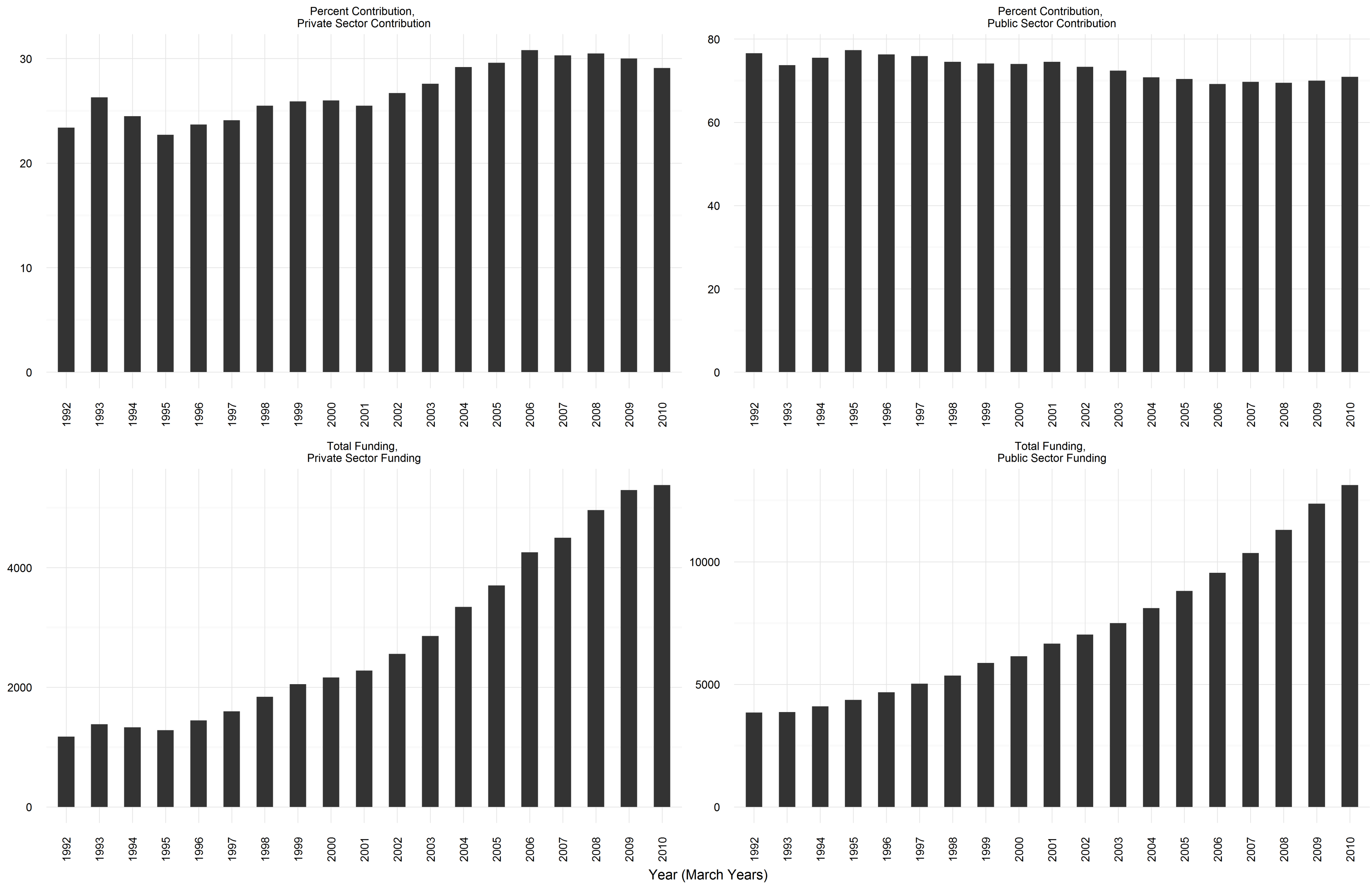


Figure 43: Health-Sector Gross Output Funding Contribution - Public / Private Sector Sources



A.2.3 Impact on Health Sector Incomes

While the period 2000 - 2010 saw private sector health funding increase significantly, recent years have witnessed severe private expenditure retrenchment. Private expenditure decreases have driven declines in both the number of private providers delivering health care, and the number of persons they employ. Coming off a decade of strong economic growth, median income growth rates for workers in the different health industries have slowed in recent years. The industries have also been affected unequally.

Figure (44), from SNZ's Linked Employer-Employee Database (LEED), measures the quarterly median earnings for employees within the different health-sector industry over time.

Given the different workforces skill mix, their composition and the nature of health-services they provide, the median incomes of each industry are likely to (and do) differ significantly between each industry. DHBs have the highest median earnings, followed by the "Other health care services" and the Diagnostic health-service industry. "Other health care services", which include ANZSICs Q859100 (Ambulance Services) and Q859900 (Other Health Care Services NEC), show the second highest median earnings after DHBs.

At the other end of the income spectrum, Residential Care Services and Other Social Assistance - within the DSS health-service sector - have the lowest median wage across all health industries. As the second largest employer within the health-sector, employment growth within the DSS sector has been in the lowest paid health-sector jobs. Figure (45), derived from Figure (44) data, with the quarterly variation smoothed to reveal the underlying trend, illustrates how quarterly median incomes have changed over time. Other Health Care has both the second highest median worker earnings within the health-sector and has shown the largest increase over time.

The slowdown in Allied Health employee earnings growth around 2008 reflects the decline in private sector spending, probably related to the financial issues felt generally at that time. The elderly are significant consumers of health care. If their and other health care consumers financial wealth were diminished at that time, then conceivably their Allied Health care expenditure might reduce, impacting on enterprise numbers, employment growth and median incomes.

"Other Social Assistance services" median income growth differs significantly from other industries. For approximately four of the ten boom years, employee median earnings growth stagnated while other incomes increased significantly. Even with an increase in median earnings over recent years, employees within this industry are still the lowest paid (Figure 44), and have experienced the least earnings growth (Figure (45)

Figure 44: Health Sector Median Earnings - LEED

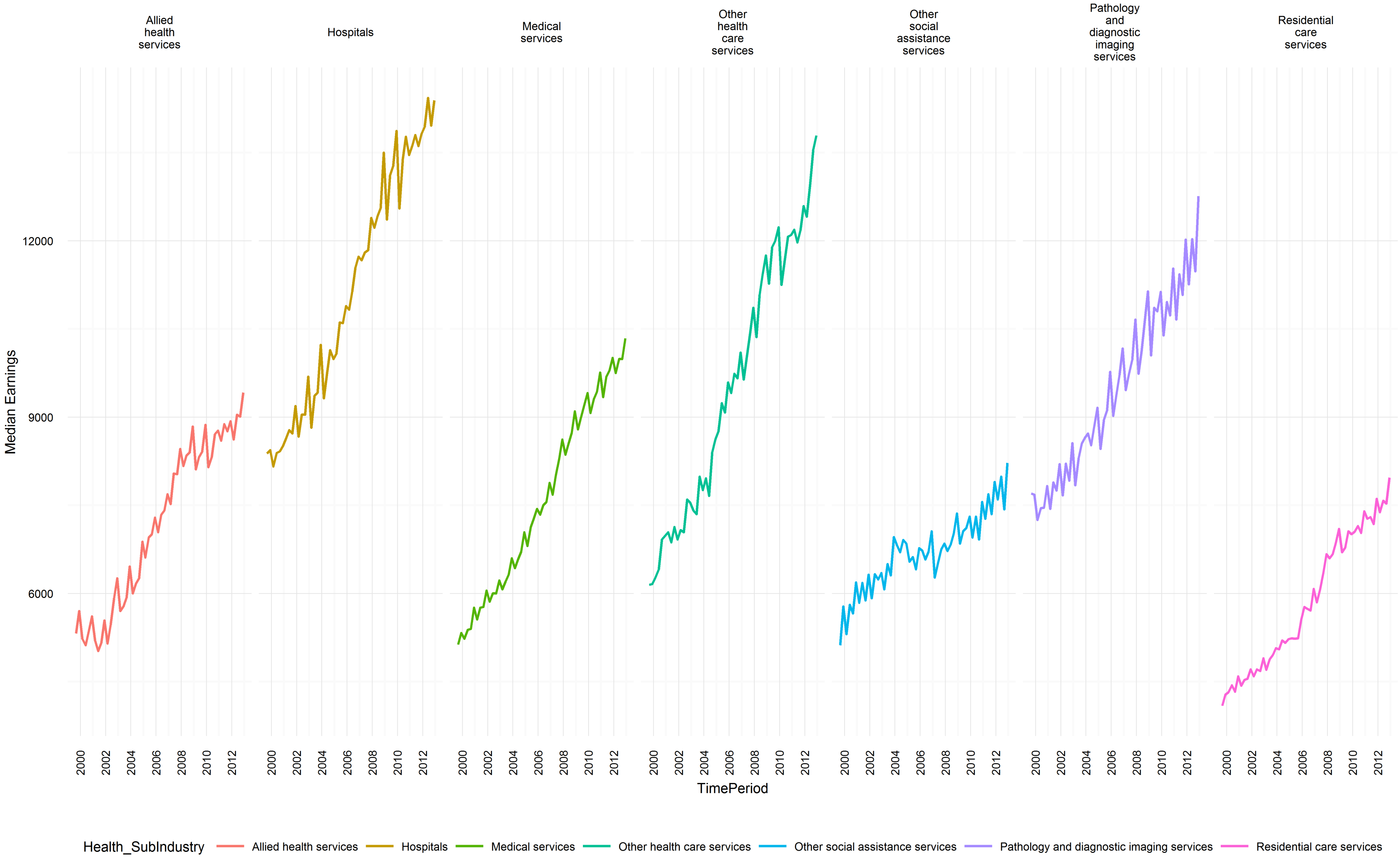
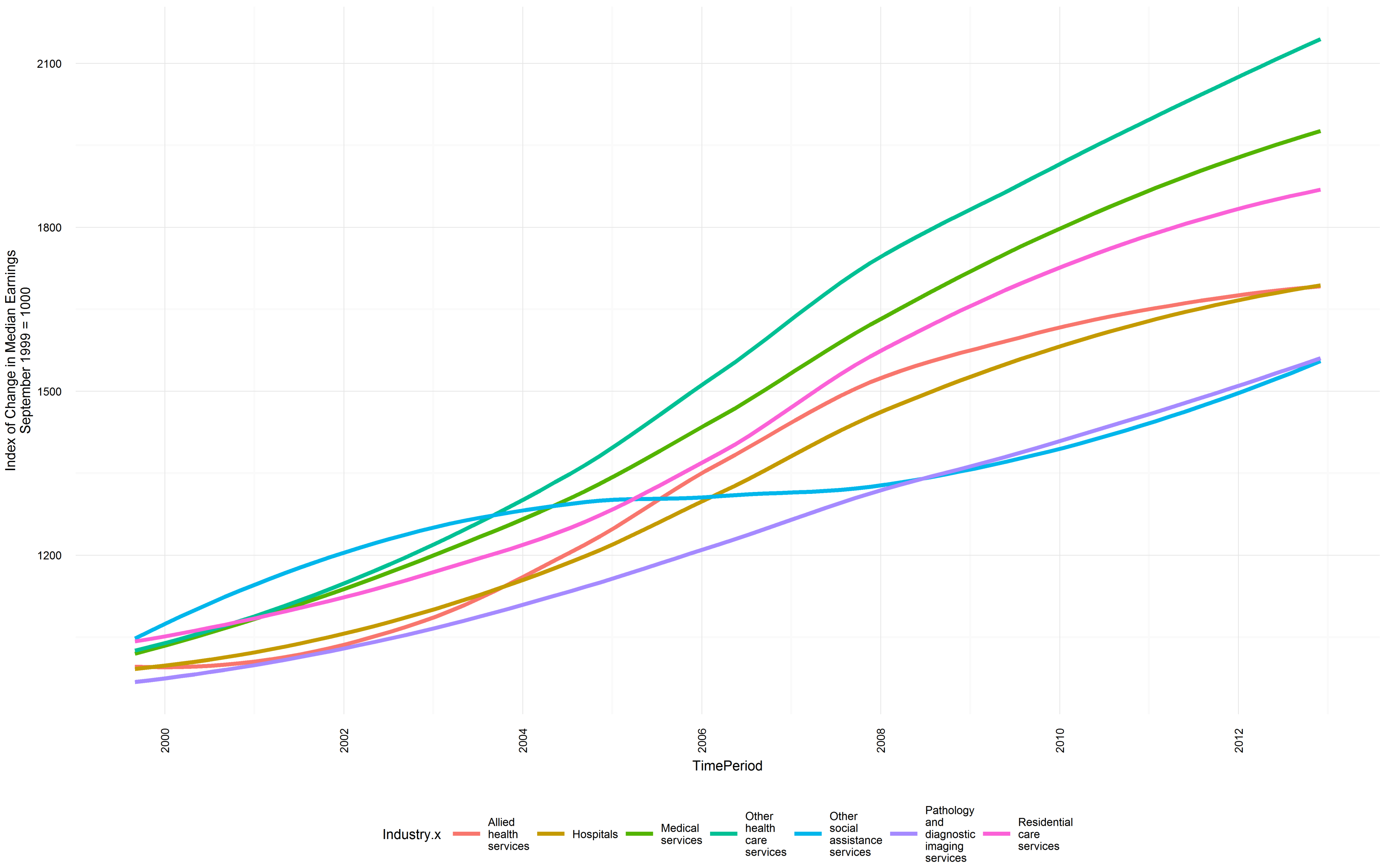


Figure 45: Change in Median Earnings - LEED



A.3 District Health Boards

A.3.1 Funders and Providers of Health Care

The vast majority of health-services are delivered by DHBs who operate in a highly non-competitive health-service output market. DHBs were established as Crown Entities by the New Zealand Public Health and Disability Act 2000 (PHDA) taking over both the funder and provider roles which had been previously split between the Health Funding Authority(HFA), as funder, and Health and Hospital Service (HHS) healthcare providers. Section 95 of the PHDA formally dissolved all of the HHS and vested their assets in DHBs, establishing each DHB's "Provider Arm". Section 25 of the PHDA empowered the DHB to purchase health-services from third parties, establishing their "Funder Arm".

Operationally, DHB Funder Arms are funded through Vote Health to purchase health care for each DHB population. DHBs are required to submit annual Production Plans to the MoH as part of the Accountability Framework[73] governing DHB funding and monitoring. Both the Funder and the Provider Arm are accountable to a common Chief Executive Officer and a common Governance Board with a Minister of Health appointed DHB Chair.

DHBs dominate the health-sector's employment statistics and are the main mechanism for Central Government-funded health-service delivery. New Zealand has a large number of private sector health providers delivering in the Primary Health, DSS, Diagnostic, and Allied health-sectors; however, Government funding still dominates these industry's funding sources.

Each year, the MoH compiles from its DHB monitoring information an estimate of the value of expenditure spent on different health-service areas split by DHB Funder/Provider Arm and Major Service Groups (MSG). Figure (46) presents how aggregate health-service expenditure has changed over time, split by DHB Funder/Provider arms and MSG.

[73]http://www.nsfl.health.govt.nz/apps/nsfl.nsf/menumh/Accountability+Documents

Funder Arm health expenditure is dominated by a "Remainder" group: a grouping derived by this thesis to reflect health-service expenditure not captured within the other MSG groupings. The major components of the Funder Arm Remainder group in 2011 were:

- Inter-district transfer payments between DHBs ($ 1.209 bill)
- Pharmaceutical expenditure ($1.017 bill)
- Capitation-based funding to Primary Care ($762 mill)
- Laboratory costs ($233 mill)

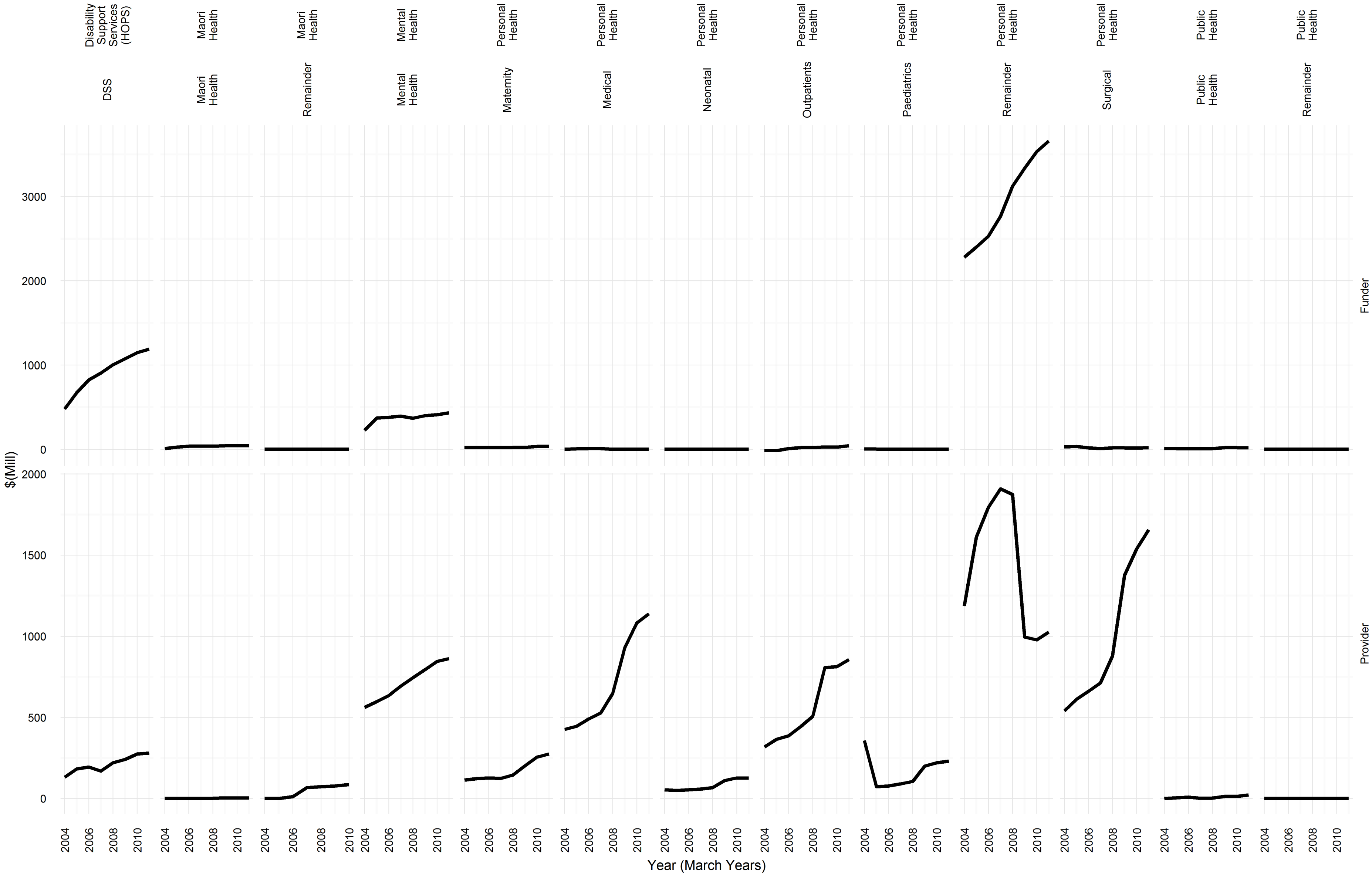
DSS and Mental Health are the two other largest recipients of DHB-originated funding, although showing different funding histories compared to similar services provided through DHB Provider Arms (Figure (46)). Funder Arm DSS received approximately $1.190 billion in 2011, having increased from $478 million in 2004, and reflecting a high average annual 14% increase in health funding over this time. Provider Arm DSS has increased by an average annual 11.4% over the same period. Funder Arm Mental Health increased from $224 million in 2004 up to $433 million in 2011, an average annual increase of 10% each year. Within DHB Provider Arms, Mental Health expenditure increased from $562 million to $862 million over the same time, a 6.3% annual average increase in health-service funding.

While both DSS and Mental Health Funder Arm funding have increased faster than the same MSG service provided by DHB Provider Arms, the nature of the services being funded involve significantly different models of care. Changes from hospital-based to community-based Mental Health care in the mid-1990's imply most of the capital costs associated with mental health-service delivery now exist within the private sector rather than within DHBs. Provider Arm-based mental health-services now mainly focus on short-term inpatient care to stabilise patients experiencing acute mental health illness. Community-based mental health-services focus on the patient's continued support within the community and involve a much longer-term care focus.

Within DSS, [Thornton(2010)] found the proportion of private sector funded Aged Residential Care clients were falling over the period 2000 - 2008, whilst over the same time, the number of Government subsidised clients were increasing.[74] Given low worker median earnings and low median earnings growth rates, together with New Zealand's increasingly

[74] [Thornton(2010)] Table 25, page 77

Figure 46: Health Expenditure by Major Service Group: DHB Funder/Provider



elderly population[75], the increased DSS funding through DHB Funder Arms has more than likely expanded the volume of DSS care purchased from private sector DSS providers to reflect both the increasing elderly demand, and a shift from private to publicly-funded DSS care.

Financial Year	DSS	Maori Health	Maternity	Medical	Mental Health	Neonatal	Outpatients	Paediatrics	Public Health	Remainder	Surgical
2004	478,091	8,569	18,803	752	223,617	-49	-16,587	3,559	12,165	2,279,143	27,715
2005	673,233	24,833	19,598	6,687	370,444	-54	-16,916	4,056	8,736	2,399,164	35,154
2006	824,396	35,349	19,562	9,291	380,030	658	8,922	-61	6,000	2,528,508	16,782
2007	904,285	40,153	20,670	8,900	392,533	208	19,195	120	5,763	2,766,647	8,269
2008	1,002,162	36,901	22,547	899	369,219	80	21,112	545	9,805	3,123,841	16,302
2009	1,074,311	42,254	21,785	3,103	398,955	-68	28,540	-166	19,626	3,336,957	17,405
2010	1,147,400	43,100	33,805	1,254	409,120	-81	25,024	164	19,807	3,532,354	13,465
2011	1,190,230	42,368	33,019	761	433,297	5	41,879	174	15,954	3,660,611	19,494

Table 12: DHB Funder Arm Health Expenditure Over Time ($000)

Financial Year	DSS	Maori Health	Maternity	Medical	Mental Health	Neonatal	Outpatients	Paediatrics	Public Health	Remainder	Surgical
2004	131,423	869	113,763	425,977	561,227	54,262	318,251	357,037	-66	1,185,873	539,934
2005	182,722	611	123,061	445,146	597,205	49,284	364,346	73,405	4,023	1,610,235	611,159
2006	193,519	1,006	126,201	490,180	635,064	54,002	387,012	77,635	9,185	1,806,643	661,578
2007	169,812	670	123,992	526,935	693,063	57,823	443,395	89,913	1,683	1,975,921	712,140
2008	220,999	1,243	144,922	648,047	743,477	66,732	506,603	104,358	3,592	1,945,941	878,262
2009	240,407	3,937	201,693	929,227	794,349	110,649	807,151	200,283	12,963	1,071,771	1,376,316
2010	274,603	2,861	255,842	1,082,949	844,854	126,877	812,310	220,022	12,456	1,064,032	1,538,055
2011	279,844	4,909	274,100	1,138,656	861,871	126,044	855,782	230,089	22,246	1,026,095	1,656,700

Table 13: DHB Provider Arm Health Expenditure Over Time ($000)

Despite private sector hardship over 2010 - 2013, and Government pressure for DHB's to be "financial sustainability", DHB Provider Arm workforces continued to expand.[76] Provider Arm health-service expenditure growth occurred within Personal Health Surgical, Medical and Outpatient health-services. The National government, elected in 2008, made reducing elective surgery waiting times one of its health manifesto commitments. Once elected, Provider Arm Personal Health Surgical health-service funding increased from $878 million for the year ending June 2008, up to $1.37 billion for the year ending June 2009, a 57% increase in total funding (Table 13).

The Provider Arm "Remainder" group in Table (13) comprises expenditure that has either no underlying health quantity measures, or were payments for services whose quantities were either unmeasured or poorly measured. Community provided health care, like district nursing, tends to be poor measured within DHB systems.

In 2011, the Provider Arm "Remainder" group larger spending items were:

- Emergency Services ($167 mill)
- Price Adjusters and Premium ($159 mill)

[75] [Thornton(2010)] Figure 37, page 78

[76] Table (**??**)

- Domiciliary District Nursing ($133 mill)
- Child (School) Dental Services ($81 mill)
- Community based Allied Health ($56 mill)
- Child and Youth ($49 mill)
- Chronic Disease Management and Education ($30 mill)

A.3.2 ”Good Employer” Obligations

Figure 47: DHB Objectives: Section 22 New Zealand Public Health and Disability Act 2000

22 Objectives of DHBs

(1) Every DHB has the following objectives:

(a) to improve, promote, and protect the health of people and communities:

(b) to promote the integration of health services, especially primary and secondary health services:

(ba) to seek the optimum arrangement for the most effective and efficient delivery of health services in order to meet local, regional, and national needs:

(c) to promote effective care or support for those in need of personal health services or disability support services:

(d) to promote the inclusion and participation in society and independence of people with disabilities:

(e) to reduce health disparities by improving health outcomes for Maori and other population groups:

(f) to reduce, with a view to eliminating, health outcome disparities between various population groups within New Zealand by developing and implementing, in consultation with the groups concerned, services and programmes designed to raise their health outcomes to those of other New Zealanders:

(g) to exhibit a sense of social responsibility by having regard to the interests of the people to whom it provides, or for whom it arranges the provision of, services:

(h) to foster community participation in health improvement, and in planning for the provision of services and for significant changes to the provision of services:

(i) to uphold the ethical and quality standards commonly expected of providers of services and of public sector organisations:

(j) to exhibit a sense of environmental responsibility by having regard to the environmental implications of its operations:

(k) to be a good employer in accordance with section 118 of the Crown Entities Act 2004.

(2) Each DHB must pursue its objectives in accordance with any plan prepared under section 38, its statement of intent, and any directions or requirements given to it by the Minister under section 33, 33A, or 33B of this Act, or section 103 of the Crown Entities Act 2004, or under section 107 of the Crown Entities Act 2004.

In addition to a range of health-related roles described in Figure (47), one of the legislated objectives of DHBs is for them to be “good employer[s]”. Section 118 Crown Entities Act outlines the requirements of a “good employer” (Figure (48)).

Through inheriting S(118)(2) Crown Entities Act 2004, DHBs are required to provide both good *and* safe working conditions for their employees. Each appointment they make to a role must have been an *impartial* selection of the successful applicant from the pool of suitably qualified persons. As good employers, DHBs have to have policies which create opportunities for individuals to promote and enhance their abilities. Finally, as good employers, DHBs

Figure 48: Good Employers: Section 118 Crown Entities Act 2004

118 Crown entity to be good employer

(1) A Crown entity must, if it employs employees,—

(a) operate a personnel policy that complies with the principle of being a good employer; and

(b) make that policy (including the equal employment opportunities programme) available to its employees; and

(c) ensure its compliance with that policy (including its equal employment opportunities programme) and report in its annual report on the extent of its compliance.

(2) For the purposes of this section, a **good employer** is an employer who operates a personnel policy containing provisions generally accepted as necessary for the fair and proper treatment of employees in all aspects of their employment, including provisions requiring—

(a) good and safe working conditions; and

(b) an equal employment opportunities programme; and

(c) the impartial selection of suitably qualified persons for appointment; and

(d) recognition of—

(i) the aims and aspirations of Māori; and

(ii) the employment requirements of Māori; and

(iii) the need for involvement of Māori as employees of the entity; and

(e) opportunities for the enhancement of the abilities of individual employees; and

(f) recognition of the aims and aspirations and employment requirements, and the cultural differences, of ethnic or minority groups; and

(g) recognition of the employment requirements of women; and

(h) recognition of the employment requirements of persons with disabilities.

(3) For the purposes of this section, an **equal employment opportunities programme** means a programme that is aimed at the identification and elimination of all aspects of policies, procedures, and other institutional barriers that cause or perpetuate, or tend to cause or perpetuate, inequality in respect of the employment of any persons or group of persons.

must have in place programmes that identify and eliminate ***all*** aspects of policies, procedures or barriers that perpetuate inequality for any person or group of persons.

The importance of S22 New Zealand Public Health and Disability Act 2000 and S118 Crown Entities Act 2004 relates to labour market theory described in Section 2 of this thesis. Briefly, one of the reasons for unions and union activity is to act as a counter-balance and check on the power of monopsony employers: single employers that can exert monopoly power to reduce employment wages and terms and conditions below a competitive market level. While DHBs do act collectively and co-coordinating their labour market efforts, S22 New Zealand Public Health and Disability Act 2000 and S118 Crown Entities Act 2004 act as a very real impediment for DHBs exerting market power to exploit the health-sector's workforce.

Legislatively, at the heart of the machinery which created them, DHBs are obliged to act fairly, impartially and act to remove inequality within their work environments, a legislative requirement seemingly at odds with the MECA agreement with the NZRDA that preference will be given to New Zealand medical graduates.

B The Health-sector Labour Market

B.1 Legislative Framework

The Health Practitioners Competence Assurance Act 2003 (HPCA) is the overarching legislation which governs who may use titles protected by the Act or claim to be practising a profession that is regulated by the Act. Essentially, no person may claim to be restricted type of health professional or practitioner unless the person *is* a health practitioner of that kind *and* holds a current practising certificate for that role. The HPCA Act deliberately acts as a barrier-to-entry into restricted health-sector professions; however, its principal purpose is the protection of public health and safety through providing a mechanisms to ensure that health practitioners are competent and fit to practise their professions.[77]

Accountability for practitioner ability is vested in 16 "Responsible Authorities" (RAs) who authoritatively determine who is, or is not, fit to deliver health-services in New Zealand. Each RA must publish the contents of their profession in terms of one or more Scopes of Practice. No health practitioner may perform a health-service unless that health-service forms part of a Scope of Practice that they are permitted to perform. And in order to receive a Scope of Practice, Practitioners must be fit for registration as a health professional and have the qualifications and abilities prescribed by the HPCA for that Scope of Practice.

All Scopes must set out the qualification or experience needed by a qualified professional to properly hold a Scope; however, there are some principles RAs need to consider when they define the minimum Scope qualifications. Section 13 HPCA requires each RA to consider only qualifications that are necessary to protect members of the public and not unnecessarily restrictions on the registration of persons as health practitioners. The minimum qualifications for each Scope should not impose undue costs on health practitioners or on the public.

The breadth and depth of each Scopes of Practice varies with each RA. For example, the Chiropractic Board oversees one single Chiropractic Scope of Practice.[78] Similarly, the Dieticians Board has one Scope of Practice[79], whose entry requirements consist of a two year Master's degree through the Universities of Otago, Auckland or Massey. Even some of the larger workforce groups have only a moderate number of Scopes of Practice governing

[77] Section 3 Health Practitioners Competence Assurance Act 2003

[78] http://www.chiropracticboard.org.nz/html/blob.php/Scope%20of%20Practice%20-%202010.pdfattach=false&documentCode=82012

[79] http://www.dietitiansboard.org.nz/webfm_send/119

Figure 49: Health Practitioner Competency Assurance Act 2003: Responsible Authorities

Responisble Authorities	Professions
Chiropractic Board	Practice Of Chiropractic
Dietitians Board	Practice Of Dietetics
Medical Radiation Technologists Board	Practice Of Medical Radiation Technology
Medical Council of New Zealand	Practice Of Medicine
Medical Sciences Council of New Zealand	Practice Of Medical Laboratory Science
Nursing Council of New Zealand	Practice Of Nursing
Occupational Therapy Board	Practice Of Occupational Therapy
Optometrists and Dispensing Opticians Board	Practice Of Optometry Practice Of Optical Dispensing
Physiotherapy Board	Practice Of Physiotherapy
Podiatrists Board	Practice Of Podiatry
Psychologists Board	Practice Of Psychology
Dental Council	Professions Of Dentistry, Dental Hygiene, Clinical Dental Technology, Dental Technology, And Dental Therapy
Midwifery Council	Profession Of Midwifery
Osteopathic Council	Profession Of Osteopathy
Pharmacy Council	Profession Of Pharmacy
Psychotherapists Board of Aotearoa New Zealand	**Practice of Psychotherapy**

their professions. The Nursing Council of New Zealand, which oversees the largest single health-sector workforce group, the Nursing profession, defines three Scopes of Practice to cover the full breadth of their professional activity.[80]

B.1.1 Entering the Medical Profession

The medical profession labour market is highly non-competitive with significant barriers existing, primarily through the Medical Council of New Zealand's (MCNZ, an RA under the HPCA Act), policies for persons seeking entry-level access into the medical profession.

Even obtaining a medical degree is supply-constrained. The number of undergraduate medical places within universities is capped to a maximum level by Government policy. If a student is successful and admitted, the tuition cost they face is the highest of any degree and its duration the longest. Medical students come out with a very high level of student loan indebtedness; however, their employment opportunities post-graduation are limited by design. Medical students must take internships within DHBs.

The limited number of positions available within DHBs for the medical student internships has acted as a barrier-to-entry for overseas-trained medical graduates obtaining work within the medical profession. Responding to the limited internship opportunities in DHBs, the

[80] Enrolled Nurse (http://www.nursingcouncil.org.nz/Nurses/Scopes-of-practice/Enrolled-nurse), a Registered Nurse (http://www.nursingcouncil.org.nz/Nurses/Scopes-of-practice/Registered-nurse) and a Nurse Practitioner (http://www.nursingcouncil.org.nz/Nurses/Scopes-of-practice/Nurse-practitioner)

MCNZ has recently limited the number of persons it allows to sit its NZREX Clinical entry exam, the first stage in obtaining a General Scope of Practice.

B.2 Obtaining a Medical Degree

The Government restricts entry into Medical degrees to 505 places across the Universities of Otago and Auckland.[81]. Medicine is also one of the most expensive per year undergraduate degrees[82] and, with a 6 year duration, the longest duration. Whether, given its high Government and Student fee structure, there is a financial incentive for Universities to prolong its duration is unclear. Likewise, the potentially role government capping of tuition places makes on keeping medical tuition fees high is likewise unclear.

Health Workforce New Zealand (HWNZ), a business unit inside the MoH, established a working group to examine the potential for a four-year Graduate Entry Programme (GEP) for medicine.[83] From both the literature and overseas experience, HWNZ found GEPs:[84]

- can produce comparable educational outcomes in shorter training time and for less cost
- may increase diversity in entrants to medical study and can help the profession achieve a better match between medical graduates and the general population, though diversity is related more to selection policies than the nature of the programme
- can draw on students with more life experience and may help to change the culture of medicine
- can result in increased student motivation, benefits to student well-being, improved learning strategies and professional outcomes

HWNZ estimated that the tuition subsidy cost to Government for a student on a GEP programme is less than for a student on any other route into a MBChB by about $35,000 - $46,500.[85] HWNZ's analysis did not include the tuition and living costs saved by the student who, through GEP is studying for a shorter period of time.

[81] http://www.minedu.govt.nz/theMinistry/Budget/Budget13/TertiaryEducation.aspx
[82] Auckland university Medical Tuition costs for 2014: https://cdn.auckland.ac.nz/assets/central/documents/2013/fees-2014-domestic-fmhs.pdf
[83] [Zealand(2011)]
[84] [Zealand(2011)] on page 4
[85] [Zealand(2011)] on page 6

Although now becoming dated, [?] estimated medical students graduate with an average $65,206 worth of study debt, having paid $11,000 per year in tuition fees. Adding two years of student tuition fee back to HWNZ's estimated of cost reduction to the Government suggests GEP could potentially have saved $46,000 - $68,000 to the cost of medical training spread across the Ministry of Education and the student.

The working group considered that the impact on the sector and the relative cost of a GEP were critical factors in any decision to proceed. Existing medical education programmes already faced challenges securing clinical internships in DHBs that ensure students have access to good quality on-the-job teaching and learning experiences. Establishing a GEP might compromising clinical access and placements in internships within DHBs. Existing medical Universities already found attracting appropriately skilled and qualified teaching staff difficult. A GEP, by a new training provider, would exacerbate University recruitment across all medical schools.[86]

B.3 DHB Internships

Union monopoly power is strengthened by non-competitive labour markets, non-competitive output markets and a low level of substitution for labour in the production process. DHB internship play a critical in giving strength to unions through significantly limiting the employments options for medical graduates, and decreasing the number of potential workforce employers.

At the heart of the medical labour market distortions are the MCNZ policies. To gain a General Medical Scope of Practice, the practitioner needs to work within a DHB for at least 1 year. Recent media attention has focused on the Medical Council reducing the number of places they make available for persons to sit the NZREX Clinical exam.[87] Citing the limited number of internship places available for candidates within DHBs, the Medical Council decreased the number of NZREX exams it offers for the 2014 year.

The lack of alternatives to DHB-based internships training requirements creates a significant economic barrier-to-entry for persons passing NZREX Clinical, and wishing to pursue a medical career. The Gazetted Scope of Practice notes applicants can seek an exemption to undertake an internship outside of a DHB setting; however, the requirements are so strict

[86] [Zealand(2011)] on page 7
[87] http://www.radionz.co.nz/news/national/240482/foreign-doctors-demand-action-on-jobs

as to put the exemption out of reach for many. To be eligible to apply for an exemption to work in primary care, the applicant must have already completed a general intern year, have passed NZREX at first attempt, have five years or more experience in primary care, and have similar primary care practice experience. The applicant's nominated supervisor must not be his/her employer.[88]

B.4 Medical Scopes of Practice

The potential for the HPCA to act as a significant *economic* barrier-to-entry occurs where an RA oversees a large variety of Scopes of Practice, each of which confers exclusive domain to a small area of a health professional field. The practice of medicine is an example where Scopes of Practice have been used to separate the profession into a number of exclusive specialities. The admission policies of the Medical Council into entry-level General scopes of practice have further increased the economic barriers into medicine. Admission criteria into advanced medical Vocational Scopes has been limited to recognising single college of medicine providers, effective conferring upon those industry bodies responsibility for controlling the numbers of persons capable to delivering services within New Zealand. The MCNZ define the practice of medicine within four types of Scope of Practice (Figure (51)).

A General Scope of Practice is applicable for doctors who are new to the medical profession; for example, doctors who have completed their first post-graduate year. Provisional general Scopes are initially conferred until the practitioner has completed the requirements for progression to a General Scope of Practice.

A Special Purpose Scope of Practice is available for Medical Practitioners who are in New Zealand for defined or limited reasons, including teaching as a visiting expert, sponsored training, research, working as a locum tenens for up to six months, or assisting in an emergency or other unpredictable, short-term situation. Special Purposes Scope of Practice do not lead to permanent registration and a practitioner with a Special Purpose Scope must work under the supervision of a registered medical practitioner for the duration of the teaching, training, research, emergency or locum tenens.

A Vocational Scope is recognised for doctors who have completed their Vocational training as a consultant and who have the appropriate qualifications and experience. Doctors registered

[88] https://www.mcnz.org.nz/assets/News-and-Publications/Gazette/Gazette-2012-A4.pdf footnote 5

Figure 50: Medical Scopes of Practice

Provisional Scopes

- Provisional General
- Provisional Vocational Scope

General Scope

Special Purpose Scope

Vocational Scope

- Pain medicine
- Anaesthesia
- Cardiothoracic surgery
- Clinical genetics
- Dermatology
- Diagnostic & interventional radiology
- Emergency medicine
- Family planning & reproductive health
- General practice
- General surgery
- Intensive care medicine
- Internal medicine
- Medical administration
- Musculoskeletal medicine
- Neurosurgery
- Obstetrics & gynaecology
- Occupational medicine
- Ophthalmology
- Oral & maxillofacial surgery
- Orthopaedic surgery
- Otolaryngology
- Paediatric surgery
- Paediatrics
- Palliative medicine
- Pathology
- Plastic and reconstructive surgery
- Psychiatry
- Public health medicine
- Radiation oncology
- Rehabilitation medicine
- Rural hospital medicine
- Sexual health medicine
- Sports medicine
- Urgent care
- Urology
- Vascular surgery

with a Vocational Scope are recognised by the Medical Council as specialists and may work independently without supervision or oversight. Doctors registered with a General Scope are not recognised as specialists. There is no limit to what General Scoped Practitioners can do (unless their Scope of Practice is specifically limited by Council) but they must work under the oversight of a doctor registered in the same or related Vocational Scope of Practice as the general Scope doctor is working in, in what is called a *collegial relationship*.

While medical professionals can hold more than one Scope of Practice, the exclusive nature of the Scopes implies that a “Urologist” skill-set cannot be used to perform a “Sports Medicine” service, or a “Neurosurgical” skill-set cannot be used to deliver “General Surgery”. The large number of field of service demarcations between the medical Scopes increase the risk that the scopes themselves create economic barriers-to-entry, not justified by medical specialisation.

B.5 Becoming Medically Vocationally Scoped

Adding yet another barrier-to-entry dimension, meeting the MCNZ's requirements for its Vocational Scopes of Practice involve becoming accredited from a very limited number of Medical Colleges. Figure (51), derived from the Medical Council's Scopes of Practice[89] presents the Medical College membership requirements needed before the Medical Council will convey a Vocational Scope of Practice. Gaining accreditation requires practitioners to become Fellows of the listed Medical Colleges.

Figure 51: Medical Vocational Scopes of Practice and their Accreditation Requirements

Vocational Scope of Practice	Accreditation College
Accident and medical practice	Accident and Medical Practitioners Association (FAMPA) or College of Urgent Care Physicians (FCUCP)
Palliative medicine	Australasian Chapter of Palliative Medicine (FAChPM)
Emergency medicine	Australasian College for Emergency Medicine (FACEM)
Sexual health medicine	Australasian College of Sexual Health Physicians (FACSHP)
Sports medicine	Australasian College of Sports Physicians (FACSP)
Public health medicine	Australasian Faculty of Public Health Medicine, Royal Australasian College of Physicians (FAFPHM [RACP]), or New Zealand College of Public Health Medicine (FNZCPHM)
Rehabilitation medicine	Australasian Faculty of Rehabilitative Medicine, Royal Australasian College of Physicians (FAFRM [RACP])
Anaesthesia	Australian and New Zealand College of Anaesthetists (FANZCA)
Musculoskeletal medicine	Certificate of Accreditation in Musculoskeletal Medicine from the New Zealand Association of Musculoskeletal Medicine (CAMM)
Family planning/ reproductive health	Diploma in Sexual and Reproductive Health(Dip SRH)
Rural Hospital Medicine	Division of Rural Hospital Medicine NZ (FDRHMNZ) of the RNZCGP
Intensive care medicine	Joint Faculty of Intensive Care Medicine of the Australian and New Zealand College of Anaesthetists (FJFICM), Diploma of Fellowship of the College of Intensive Care Medicine of Australia and New Zealand (FCICM), Royal Australasian College of Physicians (FRACP)
Oral and maxillofacial surgery	Royal Australasian College of Dental Surgeons (Oral and Maxillofacial Surgery) (FRACDS [OMS])
Medical administration	Royal Australasian College of Medical Administrators(FRACMA)
Clinical genetics	Royal Australasian College of Physicians (FRACP)
Dermatology	Royal Australasian College of Physicians (FRACP)
Internal medicine	Royal Australasian College of Physicians (FRACP)
Paediatrics	Royal Australasian College of Physicians (FRACP)
Cardiothoracic surgery	Royal Australasian College of Surgeons (FRACS)
General surgery	Royal Australasian College of Surgeons (FRACS)
Neurosurgery	Royal Australasian College of Surgeons (FRACS)
Orthopaedic surgery	Royal Australasian College of Surgeons (FRACS)
Otolaryngology Head and Neck Surger	Royal Australasian College of Surgeons (FRACS)
Paediatric surgery	Royal Australasian College of Surgeons (FRACS)
Plastic and reconstructive surgery	Royal Australasian College of Surgeons (FRACS)
Urology	Royal Australasian College of Surgeons (FRACS)
Vascular surgery	Royal Australasian College of Surgeons (FRACS)
Occupational medicine	Royal Australasian Faculty of Occupational Medicine FAFOM) within the Royal Australasian College of Physicians (RACP), or Australasian Faculty of Occupational and Environmental Medicine, Royal Australasian College of Physicians (FAFOEM) (RACP)
Obstetrics and gynaecology	Royal Australian and New Zealand College of Obstetricians and Gynaecologists (FRANZCOG)
Ophthalmology	Royal Australian and New Zealand College of Ophthalmologists (FRANZCO)
Psychiatry	Royal Australian and New Zealand College of Psychiatrists (FRANZCP)
Radiation oncology	Royal Australian and New Zealand College of Radiologists
Diagnostic and interventional radiology	Royal Australian and NZ College of Radiologists (FRANZRC)
Pathology	Royal College of Pathologists of Australasia (FRCPA)
General practice	Royal New Zealand College of General Practitioners (FRNZCGP)

Some Vocational Scopes allow some choice; for example, Accident and Medical Practice, however, the majority require membership to one of two specific colleges: the Royal Australasian Colleges of Surgeons and Physicians. Both of those two Colleges, comprised of practitioners already operating within those the medical profession, create single entry points into the medical professions requiring those specific Vocational Scopes. Overseas qualified practitioners need to satisfy the Fellowship requirements of the Royal Australasian

[89] https://www.mcnz.org.nz/assets/News-and-Publications/Gazette/Gazette-2012-A4.pdf

Colleges of Surgeons and Physicians before the Medical Council will confer a Vocational Scope of Practice to a practitioner.

C Main Health-sector Unions

Unions feature prominently in the health-sector's operation and policy debate. The major health-sector-specific unions are described further below. Other unions operate in the health-sector; for example, the Service and Food Workers Unions and the Public Service Association, but the following are the main unions focusing exclusively on health-sector professions.

- New Zealand Resident Doctors Association (NZRDA)

  The NZRDA is an incorporated society that "negotiates, protects, and improves the collective employment interests of its members"[90] collectively described as "Junior" doctors. According to the NZRDA's Rules of Incorporation, Junior doctor target members are: Trainee Interns, House Surgeons or House Officers, Dental House Surgeons, Senior House Officers, Dental Registrars, Registrars, Medical Officers from overseas registered to work in New Zealand, and Medical or Dental Officers undertaking medical training.

  While the NZRDA's membership size is unidentified, from DHBSS's Health Workforce Information Programme (HWIP) data, DHBs employed approximately 4,200 Junior Medical workers who collectively delivered approximately 3,700 full time equivalent (FTE) units of labour service as at 30 June 2013. The NZRDA called a strike in 2006[91]. At the time, 2500 Junior doctors were reported as engaged in a five-day strike. HWIP data for the same time reveals DHBs collectively employed 2,786[92] suggesting that, in 2006, the NZRDA had 90% membership of Junior doctors employed by DHBs.

  An Internet search has revealed the NZRDA has taken industrial strike action involving all its members twice in recent years, with public threats of further strikes made.[93]

[90] NZRDA Rule of Incorporation,http://www.nzrda.org.nz/wp-content/uploads/2011/04/NZRDA-rules-as-registered-13-April-20111.pdf, Clause 4.1.a

[91] http://tvnz.co.nz/content/752825/2591754/article.html

[92] HWIP Basedata, June 2006, Table 11

[93]

- five days in 2006: http://tvnz.co.nz/content/752825/2591754/article.html
- 48 hours in 2008: http://tvnz.co.nz/health-news/emotions-running-high-in-pay-dispute-1728526 News media reports note the strike occurred after 11 months of protracted negotiations. NZRDA announces second strike:

- Association of Salaried Medical Specialists (ASMS)

  ASMS is an incorporated society with a large and comprehensive range of objectives focused on protecting and promoting its members' interests in all aspects of their employment.[94] Its members are: "Any registered medical or dental practitioner employed in New Zealand and whose employment is conditional on their holding a current practising certificate".[95] Junior doctors or medical/dental professions employed in universities or elsewhere in Government are specifically excluded. [96] Given the exclusion of "Junior" doctors, ASMS is known as the "Senior" doctor's union.

  HWIP data shows DHBs collectively employed 4,800 Senior doctors who were contracted to deliver approximately 3,800 FTEs of labour as at 30 June 2013. While ASMS's membership coverage is not directly observable, its website suggests ASMS represents more than 90% of the Senior medical workforce.[97]

  ASMS is a vocal union and uses direct public advocacy to advance its goals, actively issuing media releases,[98] publishing in the New Zealand Medical Journal,[99] and seeking to enter into the policy formulation process as its main channels. Its public profile is emotive, with its media releases using language that describes negotiations as "lengthy and bitter"[100], and describing New Zealand's health care system as "prey to erratic decision-making, heavy-handed management and gaga behaviour".[101]

  As a measure of the cerebral-ism of its industrial action tactics, one of ASMS's more interesting approaches to industrial relations is to poll their members on different industrial issues and rate the performance of each DHB's Chief Executive. The results are publish on their website[102], and ASMS use their member's perspectives as evidence of DHB management performance in the media.[103] In terms of industrial relations tactics, this clever strategy has the advantage of maintaining a steady stream of "news" for media releases, keeping the interests of ASMS members at the forefront of headlines,

http://www.nzherald.co.nz/nz/news/article.cfmc_id=1&objectid=10505469

[94] http://www.asms.org.nz/includes/download.aspxID=95842 Clause 4
[95] http://www.asms.org.nz/includes/download.aspxID=95842 Clause 5.1 (a)
[96] http://www.asms.org.nz/includes/download.aspxID=95842 Clause 5.1 (b) and 5.1 (c)
[97] http://www.asms.org.nz/Site/About_Us/Default.aspx, second bullet point in second role description
[98] http://www.asms.org.nz/Site/Publications/Addresses$_{P}apers.aspx$
[99] http://journal.nzma.org.nz/journal/121-1274/3068/content.pdf, http://journal.nzma.org.nz/journal/117-1204/1115/content.pdf
[100] http://journal.nzma.org.nz/journal/121-1274/3068/content.pdf first paragraph
[101] http://www.radionz.co.nz/news/national/240866/claim-nz-hospitals-are-under-funded
[102] http://www.asms.org.nz/includes/download.aspxID=133183
[103] http://www.odt.co.nz/news/dunedin/297638/doctors-rate-sdhb-poorly

whilst presenting their findings as impartial "evidence" which can use to legitimise their engagement in health-sector policy processes without the threat of industrial strike action being used.

- New Zealand Nurses Organisation (NZNO)

  The NZNO is an incorporated society whose first objective is to "Lead the nursing profession through advocating for professional excellence and collective industrial aspirations".[104] Unlike the NZRDA or ASMS, the NZNO's constitution has a strong bi-cultural flavour, with direct reference to advancing Te Tiriti o Waitangi and the improvement of Maori health as its society objectives. Both a President and Kaiwhakahaere jointly lead the NZNO, with equal powers to act as spokespersons for the NZNO, and head the Organisation.

  The overall flavour of the NZNOs Rules are much more focused on improving both the Nursing profession and the environment nurses work within, as opposed to extracting the maximum employment conditions for their members. Both the NZRDA and ASMS's Rules of Incorporation have promoting the collective employment interests of their members as the first objective[105], the NZNO instead focuses on the improving the nursing profession's excellence and its industrial (as opposed to employment) aspirations. Even the second object of the NZNO Rules of Incorporation focus on nursing "working" conditions, as opposed to "employment" conditions.

  The scope of NZNO membership is extensive and includes: all nurses and midwives; student training in nursing or midwifery; persons employed as nursing aids in either the public or private sectors; occupational therapists, counsellors and social workers, together with private sector employed administrative persons engaged in clerical work, finances, accounts, etc. The described list is not exhaustive, with further employment occupations in-scope for NZNO membership.[106] The NZNO's strategy for the nursing profession[107] identifies their membership base at approximately 46,000 members.

  The NZNO do actively engage in industrial action, although unlike the NZRDA, the target for strike action is limited to single organisations which are points of grievance.

[104] http://www.nzno.org.nz/Portals/0/Files/Documents/About/NZNO%20Constitution%202013-2014%20.pdf

[105] NZRDA: "Negotiate, protect, and improve the collective interests of its members", ASMS: "To protect and promote the interests of members in all aspects of their employment"

[106] http://www.nzno.org.nz/Portals/0/Files/Documents/About/NZNO%20Constitution%202013-2014%20.pdf Schedule 1, Clause 1

[107] http://www.nzno.org.nz/Portals/0/publications/2020%20and%20Beyond%20-%20A%20Vision%20for%20Nursing%20-%20executive%20summary,%202011.pdf

There is not the same sense of mass strike action and all NZNO members striking in collective solidarity as is reflected in NZRDA industrial action.[108]

Unlike both the NZRDA and ASMS, NZNO runs a transparent employer bargaining strategy: its policy and goals are published on its website.[109] The NZNO maintain their bargaining strategy should be designed to improve the workplace environment and ensure nurses and other health workers are valued fairly for the work that they undertake; receive access to adequate professional support and training to sustain quality clinical practice; and are supported in their working lives through a range of other supports to enable them to enjoy healthy working lives. Their strategy aims to strengthen the collective organisation and professional autonomy within both the workplace and the wider health system.

- Association of Professional and Executive Employees (APEX)

  APEX is an incorporated society whose first objective is to: "Negotiate, protect, and improve the collective employment interests of its members."[110] Any person of "good character" can become a member if they are employed in any employment areas covered by APEX's Divisions.[111]

  APEX divisions cover: Medical Radiation Technologists (MRTs), Radiation Therapists, Sonographers, Dental Therapists, Clinical Psychologists, Clinical Physiologists, Managers, Medical Physicists, Hospital Scientists, Physiotherapists, Pharmacists, Anaesthetic Technicians, Information Technology Workers, Dieticians, and Social Workers.

  APEX members have been known to collectively threaten to strike within divisions. MRTs threatened a strike affecting nine DHBs in 2005.[112] MRTs again threatened strike action in 2010.[113]. West Coast DHBs Information Technology professions threatened

[108] Isolated targets have been DSS providers, the Oceania Group (http://www.oceanialiving.co.nz/), a provider of Aged Care and (http://www.nzno.org.nz/about_us/media_releases/articletype/articleview/articleid/1148/oceania-aged-care-workers-strike-to-go-ahead
http://www.nzno.org.nz/about_us/media_releases/articletype/articleview/articleid/1166/oceania-care-workers-step-up-strike-action
and the Rosebank Home and Hospital in Ashburton (http://www.nzno.org.nz/about_us/media_releases/articletype/articleview/article
care-workers-at-rosebank-take-strike-action)

[109] http://www.nzno.org.nz/Portals/0/publications/NZNO%20Bargaining%20policy.pdf

[110] APEX Rules of Incorporation http://www.apex.org.nz/wp-content/uploads/2011/03/APEX-rules-July-2013.pdf Clause 4.1.1

[111] http://www.apex.org.nz/wp-content/uploads/2011/03/APEX-rules-July-2013.pdf Clause 5.1

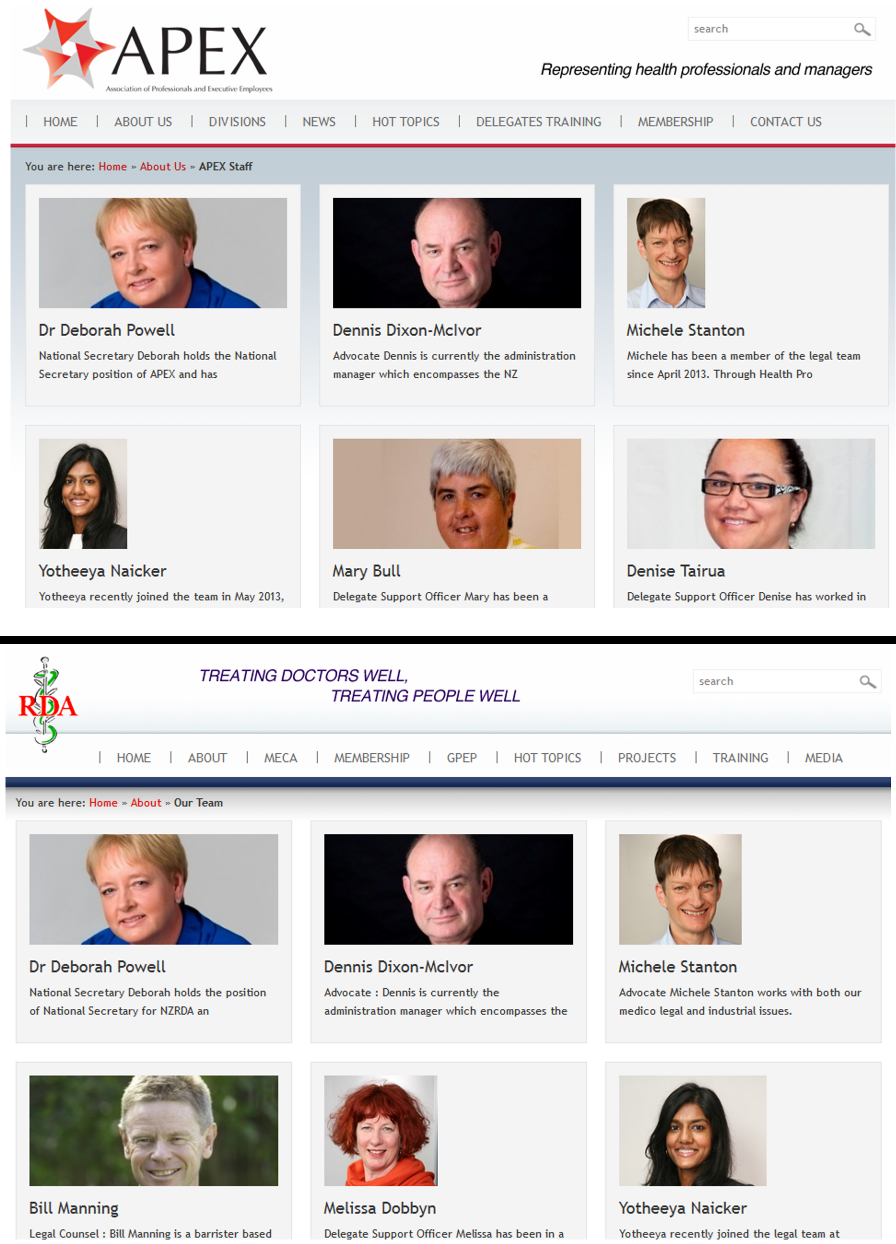
[112] http://www.scoop.co.nz/stories/GE0505/S00095/dhbs-advisory-on-apex-strike-action.htm

[113] http://www.midcentraldhb.govt.nz/News/Pages/MidCentral-Health-Receives-Strike-Notice-on-7-September-for-Medical-Radiation-Technologists.aspx

strike action in 2011 in order to get DHBs to the negotiation table.[114] MRTs threatened strike action at Timaru hospital was called off at the last moment in 2010.[115]

APEX shares common National Executive ties with the NZRDA. Eleven of the twelve members of the NZRDA's National Executive are common to both the NZRDA and APEX[116] and the NZRDA[117] (Figure (52)). Both organisations have common physical locations, mailing addresses and phone numbers.

Figure 52: APEX and NZRDA National Executive



[114] http://www.apex.org.nz/wp-content/uploads/2011/03/2011-11-18-Press-release-IT-Professionals-Strike-Notice.pdf
[115] http://www.stuff.co.nz/timaru-herald/news/4322335/Radiographers-call-off-strike
[116] http://www.apex.org.nz/page$_{i}d = 198$
[117] http://www.nzrda.org.nz/portfolio=495-2